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W. B. BIZZELL, President

BULLETIN NO. 257 DECEMBER, 1919

DIVISION OF ENTOMOLOGY

THE COTTON OR MELON LOUSE

LIFE HISTORY STUDIES

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BULLETIN NO. 257. DECEMBER, 1919.

THE COTTON OR MELON LOUSE

LIFE HISTORY STUDIES

BY

*F. B. PADDOCK, M. S.

INTRODUCTION.

For over a quarter of a century the people of this State have had to contend with the ravages of the cotton or melon louse. When the insect was first discovered in Texas it was a pest of melons, and it has always caused much damage to this class of crops. Years later a plant louse was found on the cotton in many localities in the State, but it was a few years afterward before it was known definitely that the plant louse of melons was the same species as the one attacking cotton. Even to-day there is much confusion among the growers concerning the identity of these plant lice.

The importance of this pest cannot be overdrawn when it is realized that every person who plants cotton may have to reckon with the ravages of this pest; that large plantings of melons and allied plants are often totally destroyed by the pest; and that every home garden is menaced by it. The injury caused by this insect is not always charged to it but often to the weather. The great loss which has been suffered by the presence of this pest is hard to appreciate and can hardly be estimated in terms of dollars.

Work was started on the study of this insect in March, 1916. The detail work on the life history was completed by May of 1917. Acknowledgment is hereby made of the assistance given by O. K. Courtney, formerly Assistant Entomologist, during the summer of 1916. Since October of 1916 much valuable assistance has been rendered by H. J. Reinhard, Entomologist, in all phases of the work on this insect, and due credit is given at this time.

The work has consisted of life history studies to determine the number of generations that may occur in this locality, in a period of twelve months; of migration tests to secure information on host plants; and of a study of insect relations. Collections have been made at many points within the State as well as some in other States. Seasonal notes have been made wherever possible.

HISTORY.

In 1854, Glover(1) in making a report of a trip to Columbia, South Carolina, says: "The much-dreaded cotton-louse was not found very

*Resigned September 15, 1919.

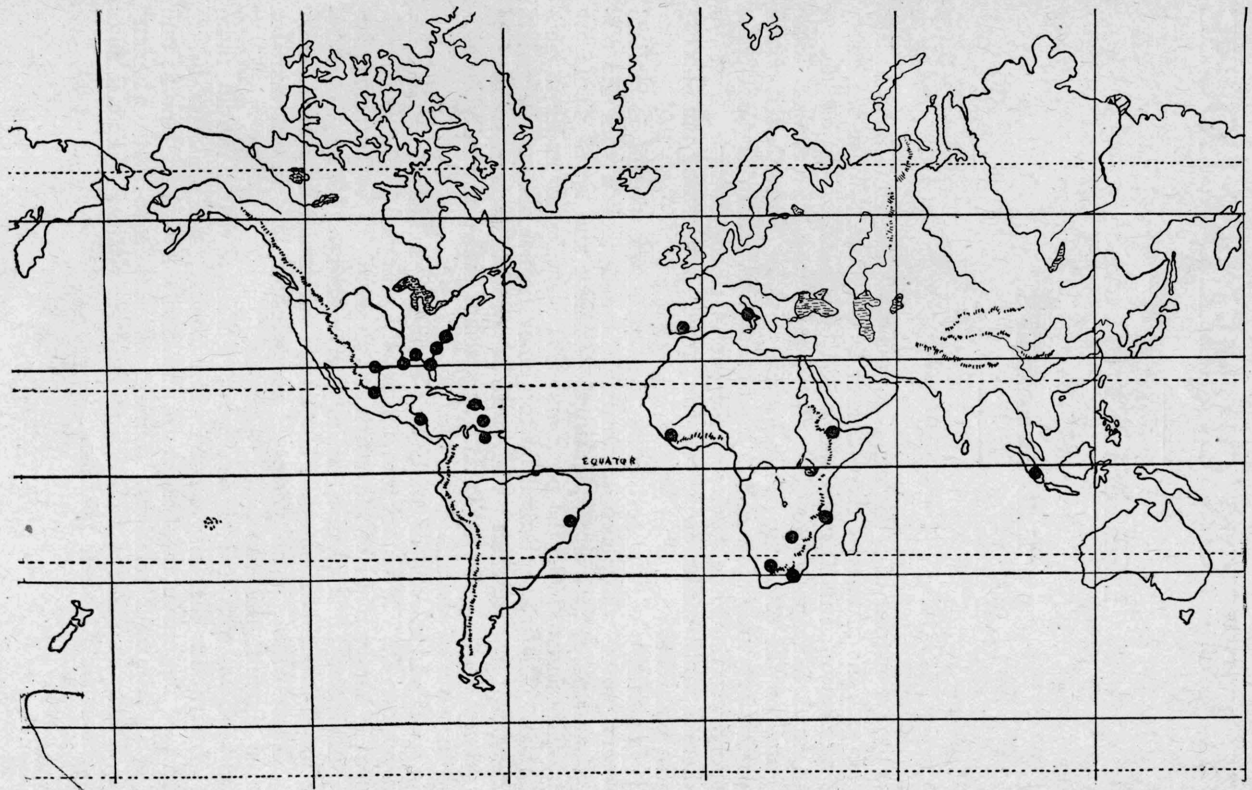

Figure 1. World Distribution.

abundantly at this late season." From this remark we are led to believe that this insect had come to be a recognized pest of cotton at that date. In another place he says, "Yet I have seen old stands in Georgia with their young shoots completely covered with this pest as late as November." From these records it is impossible to say when this insect first appeared in the United States and in exactly what locality. The insect first attracted attention as a pest of cotton.

It was not until 1882, when Ashmead(6) described his *citruilli,* that this insect was known as a pest of melons in Florida and also in Georgia. This latter locality was one of the first to suffer from the insect as a cotton pest. In 1881 the same insect was found to be a cotton pest. The following year the same insect proved very destructive to cucumbers in Illinois, although it was not described until 1883 by Forbes(8) as *cucumeris.* In 1880 this insect was reported from Florida as injurious to oranges and in the same year it was also reported from New Jersey as a pest of melons. It was also reported from Brazil that year as occurring on cotton. The following year it was recorded in Tennessee on melon vines. In 1882, Ashmead(7) in redescribing his *C. citrifolii* includes material of *gossypii,* from oranges in Florida, as a pest of that plant. This mistake was made when *gossypii* was considered as a dimorphic form of *citrifolii.*

In 1883 the insect was reported again on melons from Florida and also on melons and cucumbers from Kansas. The following year it was found on oranges in California. In 1890 it was first reported from Massachusetts and Nebraska; melons and cucumbers being the hosts in each State. It was in this year that the species was reported on oranges in Australia. The insect was first reported from Arizona and Mississippi in 1891, on melons and cucumbers in both States. The first report from Texas was in 1892, when the insect was taken on melons at Laredo; the following year it was taken on melons at Rockport. In 1892 the insect was reported on oranges from the West Indies and was taken again in 1894 from oranges. It was in this year that the insect was found on cotton in several localities in Mexico. Following this date the pest has become established in almost every State upon some one or more of its many hosts. In 1907 it was first reported on cotton from the Hawaiian Islands and recently it has been found on melons and cucumbers from Sweden.

DISTRIBUTION.

The insect was first discovered on cotton in Georgia and South Carolina. Later it was reported on melons from Florida. Soon afterwards the species was reported on melons from New Jersey and one year later from Tennessee, on the same host. At this early date, and before the pest was established widely in the United States, it was reported on cotton from Brazil. Soon it was reported from Kansas, and a year later its presence in California was recorded. Closely following these records were reports of the presence of this insect in Nebraska and Massachusetts. During the same year the presence of the species was noted on oranges in Australia. In 1892 the insect was found on oranges in the West Indies, and was recorded again in 1894 on the same host. It was not until 1907 that the insect was recorded from Hawaii,

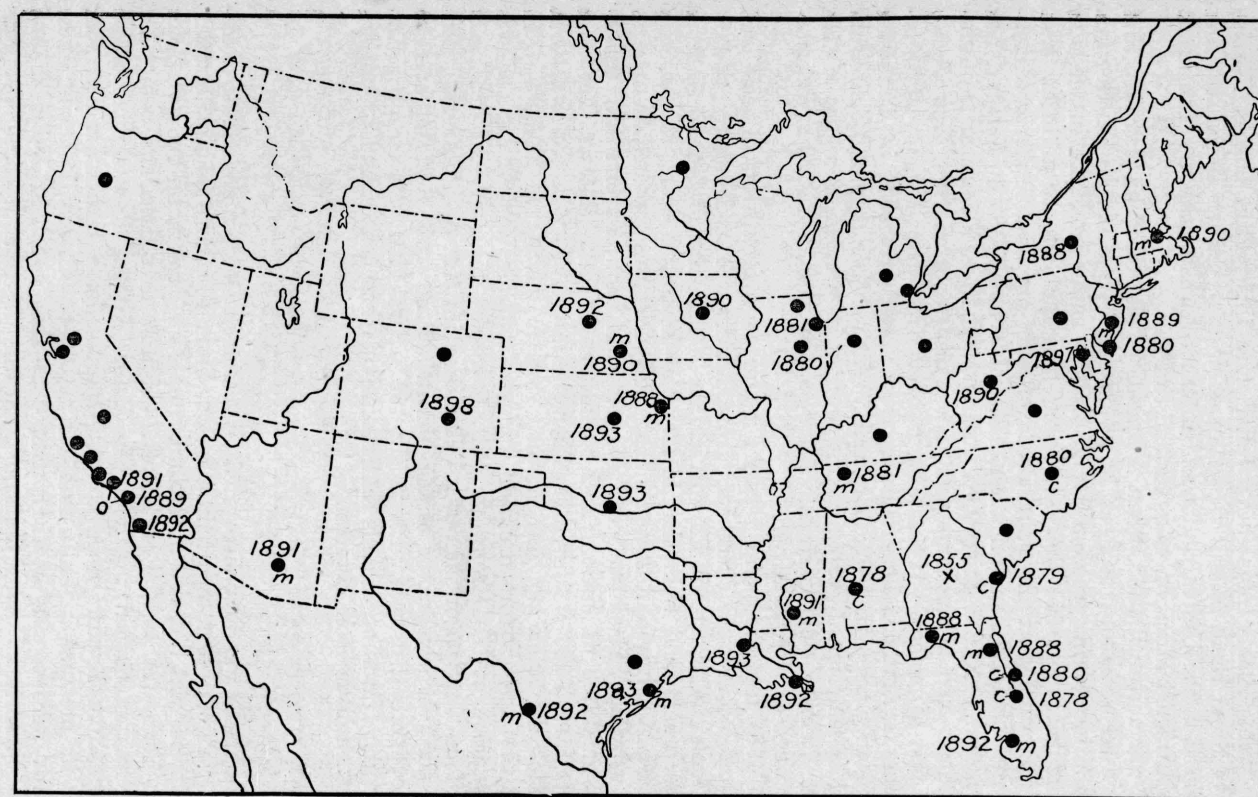

Figure 2. Chronological Distribution of this Louse in the United States.

but at that time it was found on several of the islands and on a variety of hosts.

Fig. 1 shows the present known world distribution of this species, together with the dates of the first recorded occurrence in each locality, as well as the host upon which it was first found.

In Fig. 2 is shown the chronological distribution of this insect in the United States with hosts of the early records of occurrence. In Texas, the louse is present wherever cotton, melons, and the other host plants are grown.

SCIENTIFIC NAME.

This species was first mentioned by Glover(1) in 1854 when he says, "The cotton-louse made its appearance again during the cold, damp weather of November." The location of which he spoke is assumed to be Columbia, South Carolina, and at this time he classified the insect as "Aphis ?." No description was made of the species other than, "the adult insects are said to be about one-tenth of an inch in length, often of a dark green color, sometimes black." He figured both apterous and alate forms in two views. Mention was made of the presence of this insect in Georgia, where it evidently had been a serious pest for years as it was familiar to the cotton growers.

The following year Glover(2) again mentioned the "cotton louse" in his article on Cotton Insects, as "Aphis ?," but no further information was given than was contained in the first article.

Mention of this insect was not made again until 1876 when Glover(3) makes a note of its presence and refers to the account of the pest made in 1855. At that time the specific name of *gossypii* was first applied to the species although no further description was given than that contained in his paper on the insect.

In the following year Thomas(4) in his list of aphids found in the United States, records *Aphis gossypii* without author and refers to the account by Glover(2). Thomas described the species as "green or yellow, thorax striped with black." Cotton was given as the host.

In 1880, Ashmead(5) described a plant louse from orange as *S. citrifolii* which has been considered by many writers as a synonym of *A. gossypii*. It is now considered, however, that *citrifolii* is a distinct species. In another paper during the same year, Ashmead(6) described a species of aphid from watermelons in Florida and Georgia as *A. citrulli*. This species is now considered a synonym of *gossypii*. In 1882 Ashmead(7) redescribed *citrifolii*, and it is now assumed that some of the material probably was *gossypii*. Another species described at that time as new, is now considered to be *Rhopalosiphum persicae* Sulzer.

In 1883 Forbes(8) described and figured a species of aphid as *Aphis cucumeris* which infested cucumbers, watermelons, and muskmelons. His description of the forms is as follows:

"Winged female: Head black, with red or black eyes, the latter usually with a red tubercle behind. Thorax sometimes jet black throughout, sometimes with the prothorax yellowish. Abdomen yellowish-green with black edges, and with blackish margins to segments. Legs yellow, with coxae and distal parts of tibiae and femora dusky or black. Cornicles cylindrical, black; tail yellowish, rostrum yellow, with black tip. The antennae are six jointed (apparently seven), with a setaceous tip three times as long as the basal part of the joint. The sixth joint is the longest, the third next, the fourth and fifth nearly equal. All except the basal joints are marked with imbricated transverse ridges. The wings are more than twice as long as the abdomen, hyaline, with stigma and veins dusky yellowish. The tail extends beyond the tip of the body. Width of thorax .022 inch, of abdomen .08 inch, of head .014 inch. Length of body .054 inch, of antennae .052 inch, of cornicles .009 inch."

"Pupa: Head and prothorax, base and tip of antennae dusky, eyes dark red, sides of mesothorax and metathorax white, wing pads black, abdomen brownish yellow except posteriorly, where it is green. Whole body pruinose, legs white, tarsi and tips of tibiae black."

"Wingless female: Body green or greenish-black throughout, antennae black at base and tip; cornicles black, tail yellowish, legs pale, with tarsi and tip of tibiae black. Body broad ovate, widest behind, thorax without spine. Cornicles minutely roughened. Antennae with imbricated transverse ridges, excepting the two basal joints. Body .06 inch long, .037 inch wide, antennae .05 inch in length, cornicles .013 inch."

Recent writers consider this species a synonym of *gossypii*. Forbes, however, described a root form of what he considered the same species, which was taken late in the fall in a cucumber field. Recent literature contains no reference to this form.

Oestland(9) in 1887 listed the two species, *gossypii* as occurring on cotton and *cucumeris* as occurring on *cucumis* sp. Weed in 1889 described a species of aphid from strawberry roots as *A. forbesi*. This species for several years was considered a synonym of *gossypii* but recent authorities have shown *forbesi* to be a separate and distinct species.

In 1895 Pergande(10) discussed the early history and synonyms of *gossypii* in a detailed manner. At that time *forbesi* was considered a synonym of *gossypii* and it was not until 1908 that Gillette(11) called attention to the positive distinctions of the two species.

In 1909 Essig(12) described *A. citri* Ashm. from oranges but later says the material was *gossypii*. The following year he described *gossypii* and later considered that material a new species, *A. cookii*. In 1911 Essig(13) described *gossypii* and gave figures. This description was the first detailed description of *gossypii* to occur in literature on Aphids.

Of the European species of Aphids feeding upon the same host plants none are considered a synonym of *gossypii* either in the case of cotton or of cucurbits.

The synonymy of *Aphis gossypii* Glover as understood now is as follows:

Siphonophora citrifolii Ashmead in part.
Aphis citri Ashmead.
Aphis citrulli Ashmead.
Aphis cucumeris Forbes.
Aphis cookii Essig.

ALLIED SPECIES.

From the confusion which exists in the host-plant list it is evident that many times this species has been confused with several others. *A. medicaginis* is perhaps more often confused with *gossypii* in this State than any other species. This is due to the fact that *medicaginis* is quite common on cowpeas, which are usually planted close to cotton. From the cowpeas the migration of *medicaginis* to cotton is easily accomplished, and the result is serious. This migration takes place when the cotton is very young, with only four or six leaves. The adult apterous female of *medicaginis* is a deep black in color and shines like a speck of coal. The alate females of *medicaginis* are more rounded than *gossypii* and the color is a decided black instead of the dark olive green of *gossypii*. The *cucurbits* have never been found infested with *medicaginis*. No infestation of *Rhopalosiphum percicae* Sulzer was found on melons, although this species is recorded as attacking these hosts in other localities. Only *gossypii* was found on okra in these studies. In other States it is evident that *A. rumicis* Linn. is confused with *gossypii* but this species did not appear during the time of these observations.

COMMON NAMES.

This species is spoken of as the cotton louse when it infests the cotton plant, and as the melon louse when it infests the cucurbits. The scientific name is that applied to it when the insect was known only as a pest of cotton, and the early writers attempted to give the species another name when it was found on the cucurbits. Now it is known conclusively that either the cotton louse or the melon louse refers to the same species of insect.

ECONOMIC IMPORTANCE.

Even the first accounts of this insect indicate the seriousness of the presence, when the words "much-dreaded" were used. The presence of this insect in cotton fields was then known to result in much loss to the grower. When the species first attracted attention in Illinois, it was reported to have almost entirely destroyed fields of cucumber and muskmelon vines. In New Jersey it was reported to have been "very destructive to all kinds of cucurbitaceous vines." Wherever it has appeared on citrii it has become injurious for only a short portion of the year, that being in the spring when the lice colonize on the developing twigs. This characteristic injury of oranges is found wherever the host is infested—Australia, West Indies, and the United States. The severe loss of cucurbits is suffered everywhere—Hawaii, Sweden, and the United States. Cotton in Brazil, Mexico, and the United States is greatly damaged by this pest.

The injury to cotton is not nearly so noticeable as that done to the cucurbits, since cotton is only severely stunted and will usually outgrow the injury, whereas cucurbits are usually killed outright. As cotton is grown widespread in this State and the insect has been reported on cotton from every locality, it is evident that the damage done by this pest is exceedingly great, although it is impossible to show such a loss in terms of dollars. The loss in Texas to commercial growers of cucurbits is known to be tremendous, as often an entire crop of melons is destroyed. If the loss suffered on each individual farm by the melon louse could be totaled, the result would certainly be astonishing. There is hardly a single home garden that does not suffer severely from the work of this pest. Taken collectively these losses would represent a big sum, which can certainly not be afforded in the State.

FOOD PLANTS.

The list of food plants for this species, as given by most authors, is very large and covers a wide range of genera, of both wild and cultivated plants. Pergande gave a list of twenty-six species on which this aphid has been found. This list was copied extensively by writers from that time with some additions. Gillette published an extensive list of food plants on which *A. gossypii* had colonized. More recent writers have continued to add plants to the very long list. Part of the cause for this very lengthy list of food plants is due to the inability of some to distinguish species closely allied to *gossypii*. Pergande, in his list, included the cultivated strawberry which is now known to be a host of *A. forbesi* which was at that time considered a synonym for *gossypii*. His list included other plants that are now known to be hosts for closely allied species and are not considered hosts of *gossypii*.

Pergande, in his list, gives the following plants that have not been recorded by later writers as hosts of *gossypii: Amarantus*, button weed (*Diodia teres*), chickweed (*Stellaria media*), European dogwood (*Cornus mas*), ground ivy (*Nepeta glechoma*), hydrangea (*Hortensis sp.*) hop (*Humulus lupulus*), Jamestown weed (*Datura stramonium*), mallow (*Malva rotundifolia*), plantin (*Plantago virginica*), purslane (*Portulaca oleracea*), and three seeded mercury (*Acolypha virginica*). Pergrade listed also some plants which have not been verified by later writers as hosts of *gossypii* but are now known to be hosts of other aphids. Burdock (*Arcticum lappa*), pigweed (*Chenopodium album*), and wormseed (*C. anthelminthicum*) are hosts of *A. rumicis* and bean (*Phaseolus namis*), pear (*Pyrus communis*), and red clover (*Trifolium pratense*) are hosts of *A. medicaginis*.

Gillette, in his list of food plants, gave some that have been recorded by one or more writers. These are: buckthorn (*Rhamnus carthartica*), catalpa (*Catalpa speciosa*), dandelien (*Taraxacum dens-leonis*), which is also a host of *rumicis*, dock (*Rumex crispus*) also a host of *medicaginis*, milkweed (*Ascelpias pumita, speciosa, vestita*), morning glory, and shepherd's purse (*Capsella bursa-pastoris*). The last two plants are also hosts of *A. medicaginis*. Gillette listed the following hosts of *gossyppi* which have not been recorded by other writers: Canada thistle (*Carduus arvensis*), ragweed (*Ambrosia trifida*), mares tail (*Erigeron canadensis*), (*Pyrus cornaria*), syringa (*Philadelphus coronarius*), and wild gourd (*Cucurbita foetidissima*).

Davis listed as host plants of *gossypii* (*Althaea sp.*), also an Easter lily (*Atamasco atamasco*), which have not been recorded by any other writer. Davis and Sanborn list (*Hibiscus sp.*) as a host. The lily (*Lilium candidum*) is listed as a host plant by Williams and Essig. Sanborn is the only author to list post oak (*Quercus minor*), a perennial grass (*Paspalum sp.*), and poppy mallow (*Callirhoe involucrata*) as host plants of *gossypii*. Essig recently listed the following additional hosts: *Asclepias speciosa* Torr., *Rhamnus purshiana* D. C., *Lilium speciosum rubrum*, *Asclepias vestita* H. & A., and *Lonicera sp.*

In the experiments that have been conducted only a few of the long list of plants have proved to be host plants of *A. gossypii* according to the migration test. These are: cotton (*Gossypium herbaceum*), watermelon (*Citrullus vularis*), muskmelon (*Cucumis melo*), cucumber (*C.

sativus), okra (*Hibiscus esculentus*), cowpea (*Vigna unginculata*), squash (*Cucurbita maxima*), pumpkin (*C. pepo*), gourd (*Hagenaria vulgaris*), and *Begonia sp.*

Tests were not made with a few plants that have been listed as hosts which undoubtedly are correct. These are: citron (*Citrus medica*), calabash (*Lagenaria lagenaria*), grape fruit (*Citrus grandis*), lemon (*C. limonia*), and orange (*C. aurantium*). Asparagus (*Asparagus officinalis*), and spinach (*Spinacia oleracea*) have been recorded as host plants of *gossypii*. The bush bean (*Phaseolus namis*) and soy bean (*Glycine hispida*) were tried by the migration test and never did *gossypii* colonize upon them.

In this State *gossypii* is found extensively on cotton and all of the cucurbits, but it has never been taken on citrus trees. The collections have not been sufficient so that it could be said that it never occurs on this plant. In California *gossypii* is primarily a pest of citrus, being found on the cucurbits and cotton only occasionally. In the northern States the species persists entirely on the cucurbits.

FEEDING HABITS.

This louse feeds almost entirely on the tender leaves of the host plants and usually on the under sides of the leaves. The lice first appear on cotton when the second or third pair of leaves are developing. Often the infestation increases so rapidly that these leaves become deformed and the plant is thereby stunted, since new leaves must grow to develop the plant. This condition is especially noticeable if the weather is cool, at which time the aphids can increase faster than the plants grow. As the number of lice increase the feeding is extended to larger leaves but always to the tender ones available. As the plant grows the infestation becomes scattered over more leaves. Only in cases of extreme infestation are the lice to be found on the developing leaf stems. Occasionally the lice may be found feeding inside the bracts at the base of the squares. This practice is more common during the extremely hot part of the summer. Very rarely the lice are found inside the opening blooms. This practice is also confined to the summer period. During the fall months the lice confine their feeding to the under sides of the leaves. A developing leaf which becomes badly infested will be shed by the plant, but usually the lice have found new feeding areas before the leaf actually falls.

When the lice are feeding on the melons and allied vines, the infestation begins on the developing leaves, which is usually at the time when the vines have started to run well. Here the feeding is confined to the under sides of the leaves entirely. New infestation always occurs near the growing tip. As the infestation increases the larger leaves are selected for feeding.

The lice may infest okra when the young plants are just putting out the second pair of leaves. Usually the plants are able to outgrow an aphid infestation. As in summer feeding on cotton, on this host plant the aphid also works around the flowers and occasionally on the very young pods.

On pumpkins and squash the slight infestation is confined to the under sides of the very tender leaves. The young plants of these hosts are seldom attacked by the lice.

METHODS OF STUDY.

For the purpose of observing the details of the life history of this species, individual aphids were isolated in cages. The type of cage used is shown in Plate I. This consisted of a large street-lamp globe No. 2, with a collar of two-inch brass gauze on the bottom, and a top made of similar material. By means of this cage, it was possible to keep growing plants in excellent condition, even throughout the hot part of the summer, as the construction was such that a current of air could constantly pass over the plants. Furthermore, such an environment was more natural for insect activities than it was possible to secure in the cages formerly used for this purpose. The cages were kept in the Insectary, shown in Plate II, during the cooler portions of the year and during the extremely hot period the cages were placed in the Cage Shelter, shown in Plate III. The temperature and moisture conditions of these situations were recorded by a hygro-thermograph.

For the generation series, cotton was used as the host plant; the type of seedling used being shown in Plate I. This plant was chosen because it was more hardy and could withstand the extreme heat of the summer much better than other host plants. It developed that the lice would persist on this host throughout the entire year. The plants were kept in excellent growing condition throughout the period they were used and one plant was usually sufficient to extend through the period of a generation. The young were transferred each day from the plant by means of a camel's-hair brush so that the delicate young were not injured in any way. The adult lice were seldom disturbed on the host plant so their movement upon the plant was very little and apparently natural.

In the work with the artificial migration tests, small plants of all hosts were used. In this work some of the plants were changed during the notes, but it was impossible to detect that this made any difference in the results obtained. For the field notes and seasonal observations, cages as shown in Plate IV were used. The large cage, 4 feet by 6 feet by 6 feet, was covered inside with thin muslin so as to prevent lice from contaminating the infestation inside. This covering made no difference in the records as far as it was possible to detect. This type of cage was found to be very satisfactory for field observations since it was large enough to study the insect on different host plants under the same conditions. At the same time the infestation in the cage could be more or less controlled.

LIFE HISTORY.

The life history of this insect has been mentioned in an indefinite way by many writers. Among the early writers, the general scheme of the life history of aphids was known only in a vague way. Then came the period when the sexual forms were understood in the economy of the plant lice. As a result, the statement was made that the winter was provided for by the appearance of true sexes in the aphids which produced eggs to carry the species over that unfavorable season of the year.

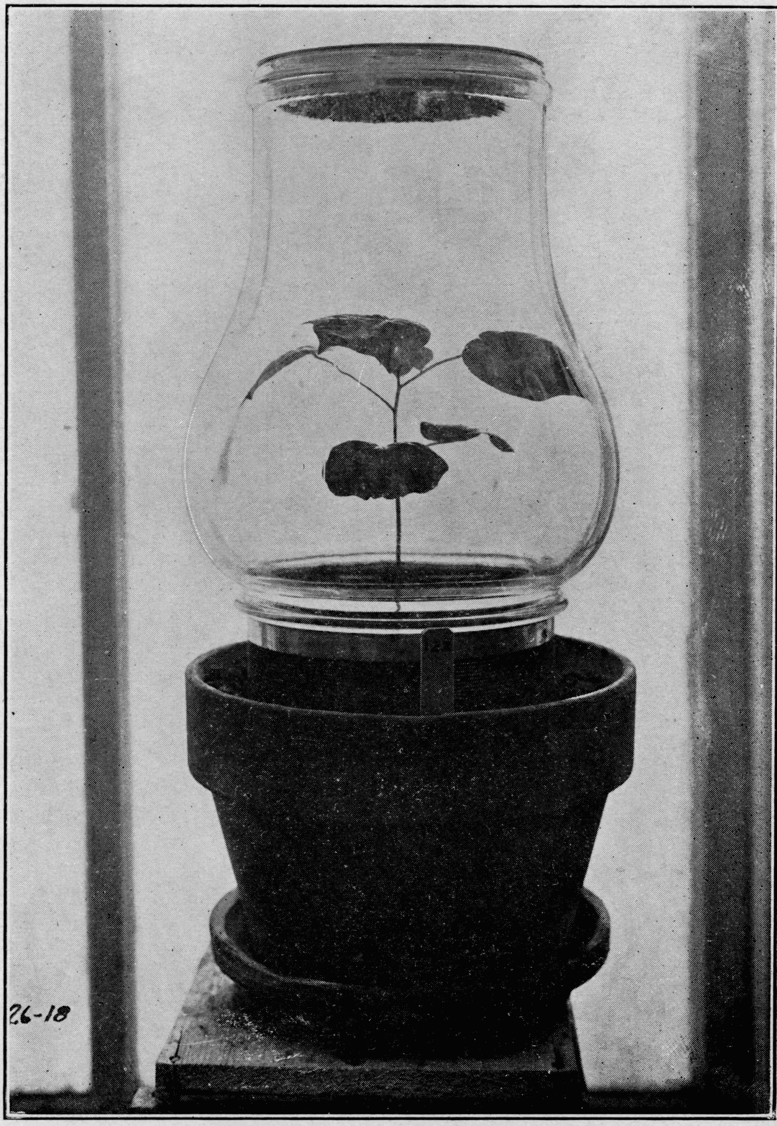

Plate I. Type of Life History Rearing Cage.

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Recent investigations have shown that in the southern part of the United States, the sex forms of aphids do not appear even when in the northern sections the sexes do occur as in the "green bug" *Toxoptera graminum* Rond. The dividing line in the case of this insect was determined by Webster and Phillips to approximate the 35th parallel. That aphids do persist throughout the year by viviparous development was shown to be true of the turnip louse, *A. pseudobrassicae* Davis by the writer. The observations recorded in the following pages will show that *A. gossypii* can be perpetuated through an indefinite number of generations over a period of more than twelve months on the same host, without sex forms appearing.

The sex forms of *gossypii* have not been recorded by any writer. In 1908 Gillette(11) records observations on this species in Colorado, when the viviparous forms persisted throughout the winter on outdoor hosts. In 1915 Davis recorded that his search had failed to reveal the sex forms of this species. In a recent paper Lochhead(17) mentions eggs of this species having been found on purslane and strawberry. The paper makes no mention of the sex forms nor that these eggs were observed to develope into *gossypii*. These hosts of *gossypii* are listed only by Pergande and have not been verified by recent investigations as being hosts of the viviparous forms of the species. Gillette in his paper indicated that his records tend to show that these are not hosts.

The fact that sex forms have not been found, leaves a space of time when the existence of the species cannot be accounted for in the north. The matter of alternate host plants has been well observed by Gillette when during the winter, *gossypii* was found colonized on the wild native plants. In this State the species has not been taken on a single wild host plant; and although in the cages it has been possible to rear the insect throughout the year, there is nevertheless a considerable portion of the year when it has not been taken in the fields.

Description of Forms.

Thomas in 1878 recorded *gossypii* as "green or yellow, thorax striped with black." This form was taken from cotton. Pergande in 1895 noted an "extreme variability of coloration both in adults and larvae, whether on the same or different plants; whereas all the important structural characters remain the same in all." Again in 1911 Gillette says: "There is always much variety of color in both the young and the adult apterous individuals, some being very dark; to the naked eye appearing black, and others with intergrading shades passing to very light yellow or tan viviparous females. The offspring of these light individuals may be as dark as the darkest through their entire life." It is quite probable that this great range in coloration, together with the wide range of food plants, has led to some confusion as to the identity of the species, especially among the early writers.

The color variation and the behavior have become a very interesting phase of the investigation of the species, but the details of this work will be published later. It will become evident, from records given on other pages, that the color forms of this louse are very distinct and their behavior is well defined. Further than the observations mentioned by Gillette, it is now known that there is a light and a dark color form, and the alate and apterous lice may be of either color. The light form has a place in the seasonal history of the species for on some hosts only light form has been known to exist. In the same way on other hosts only the dark form ever occurs. Only the dark form has been described in literature as typical of the species, and these descriptions vary somewhat. The description of the dark form by Essig(13) is the most recent and the most complete. It is given herewith.

Winged viviparous female: Length of body not including stye 1.35 mm., width of mesothorax 0.42 mm., greatest length of abdomen 0.65 mm., wing expansion 5.10 mm. Very small form.

Prevailing color: Dark, black or very dark green or brown. Head much wider than long, black. Eyes very dark red or brown. Antennae —arising directly from the head, not as long as the body, reaching to the bases of the cornicles, sparsely haired; articles I and II dusky, III with light base and remainder dusky, IV and V light yellow with apical halves dusky, VI dusky throughout; length of the articles: I, 0.07 mm.; II, 0.04 mm.; III, 0.22 mm.; IV, 0.17 mm.; VI, 0.37 mm.; (spur 0.26 mm.); total, 1.04 mm.; from seven to eight large circular sensoria on article III, remaining article normal. Rostrum—reaching to or slightly beyond third coxae, lemon yellow with the base and tip dusky. Prothorax—sightly wider than the head, but no longer; black, with distinct lateral tubercles. Meso and metathorax—black with prominent muscle lobes. Abdomen—smooth dark green or greenish brown, with an irregular lighter area on the dorsum, ventral surface dull green, small lateral marginal tubercle extending from sides, anal plate dusky, hairy. Cornicles—cylindrical, dider at base and gradually tapering to tip, imbricated, black, curved slighty outwardly in some specimens, length 0.2 mm. Legs—normal, hairy, coxae black, femora of third pair yellow, apical three-fourths dusky, tibiae yellow with dark tips, tarsi dark. Wings—rather large for the size of the species, hyaline. Primary—length 2.3 mm., width 0.95 mm., costal vein dark and well defined; sub-costal wide, yellow; stigma long and narrow, tapering from the base of the stigmal vein to a point at the tip, amber in color, length 0.65 mm.; first discoidal twice-branched and curved slightly inwardly, first branch arising near the middle of the vein, the second branch arising nearer the tip than middle of the first branch—both of these branches curve toward the third vein. All veins are amber. Secondary —length 1.5 mm., width 0.55 mm.; subcostal curved downwardly at the base of the second discoidal and then curves upwardly to point of wing; discoidals nearly straight. Style—conical or nearly cylindrical, hairy, green, with dusky tip, length 0.11 mm., a little more than half as long as the cornicles.

Apterous viviparous female: Length of body not including style 1.8 mm., width of abdomen 0.9 mm. Larger than the winged form and more robust, although many are oblong in shape, not as robust as the apterous forms of Toxoptera aurantiae Koch. Some slightly pruinose.

Prevailing color: Black or dark olive green. Head—well rounded in the front, nearly as long as wide, black. Eyes—dark red or brown. Antennae—not arising from frontal tubercles, but direct from the head, much shorter than the body—not reaching to the bases of the cornicles; articles I and II dark, III and IV light lemon yellow, V light yellow with a dark tip, VI dusky throughout; lengths of the articles: I, 0.08 mm.; II, 0.06 mm.; III, 0.32 mm.; IV, 0.25 mm.; V, 0.21 mm.; VI, 0.35 mm. (spur 0.25 mm.); total, 1.27 mm.; all articles sparsely haired; sensoria on articles V and VI normal. Rostrum—reaching just beyond the third coxae, lemon yellow with dark base and tip. Prothorax—very short, with distinct lateral tubercle. Meso and metathorax—narrow transversely. Abdomen—smooth, dark green with irregular lighter markings on the dorsum and with small marginal tubercles on the sides, ventral surface dull green. Anal plate—Dusky, hairy. Cornicles—cylindrical, widest at base and gradually tapering to tip, imbricated, black, length 0.27 mm. Legs—normal, coxae dark, femora light yellow, tibiae light yellow with dark tips, tarsi dark. Style—conical or nearly cylindrical, hairy, dusky green to dark brown, length 0.13 mm.

The sex forms of this species and eggs have not been observed and described.

Table 1. Generation Series

Date	Temperature			1st G.	2nd G.	3rd G.	4th G.	5th G.	6th G.	7th G.	8th G.	9th G.	10th G.	11th G.	12th G.	13th G.	14th G.	15th G.	16th G.	17th G.	18th G.	19th G.	20th G.	21st G.	22nd G.	23rd G.	24th G.	25th G.	Humidity		
	Max.	Min.	Mean.																										Max.	Min.	Mean
1916																															
Mar. 25	82	79	79.5	B																									59	50	54.5
26	79	71	75																										48	31	39.5
27	71	66	68.5																										35	30	32.5
28	69	67	68																										36	28	32
29	74	69	71.5																										45	26	35.5
30	76	71	73.5																										54	38	46
31	76	73	74.5																										56	45	50.5
April 1	77	70	73.5																										64	47	55.5
2	76	70	73																										69	45	57
3	70	65	67.5	1	B																								50	46	48
4	70	64	67	2																									50	46	48
5	70	65	67.5	3																									64	53	58.5
6	73	70	71.5	2																									58	54	56
7	73	69	71	0																									57	53	55
8	69	64	66.5	2																									54	43	48.5
9	67	60	63.5	2																									46	32	39
10	64	60	62	3																									45	38	41.5
11	84	65	74.5	3																									52	45	48.5
12	83	77	80	4																									51	42	46.5
13	81	75	78	2																									56	45	50.5
14	82	75	78.5	2																									60	47	53.5
15	81	73	77	3	3	B																							65	49	57
16	75	69	72	3	4																								55	49	52
17	75	72	73.5	4	4																								58	52	55
18	82	77	79.5	4	3																								61	38	49.5
19	84	75	79.5	3	3																								61	38	49.5
20	82	76	79	12	4																								60	50	55
21	82	72	77	11	4																								59	27	43
22	79	74	76.5	2	5																								36	21	28.5
23	83	73	78	7	4																								52	24	38
24	80	70	75	D	3																								58	46	52
25	79	76	77.5		2	2	B																						55	43	49
26	80	76	78		2	2																							47	37	42
27	76	69	72.5		1	1																							52	43	47.5
28	71	65	68		4	2																							44	38	41
29	71	69	70		4	3																							43	36	39.5
30	73	71	72		4	3																							48	40	44
May 1	77	74	75.5		4	1																							56	48	52
2	73	68	70.5		3	3																							66	57	61.5
3	73	70	71.5		1	D																							60	55	57.5

Table 1. Generation Series—Continued.

Date	Temperatture			1st G.	2nd G.	3rd G.	4th G.	5th G.	6th C.	7th G.	8th G.	9th G.	10th G.	11th G.	12th G.	13th G.	14th G.	15th G.	16th G.	17th G.	18th G.	19th G.	20th G.	21st G.	22nd G.	23rd G.	24th G.	25th G.	Humidity		
	Max.	Min.	Mean.																										Max.	Min.	Mean.
4	72	64	68	...	D	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	58	42	50
5	75	67	71	...	...	...	3	B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	57	42	49.5
6	79	74	76.5	...	...	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	58	51	54.5
7	80	75	77.5	...	...	...	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	59	51	55
8	82	79	80.5	...	...	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	56	51	52.5
9	85	81	83	...	...	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	55	49	52
10	87	82	84.5	...	...	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	55	46	50.5
11	88	79	83.5	...	...	...	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	59	44	51.5
12	87	75	81	...	...	...	3	3	B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	55	37	46
13	87	80	83.5	...	...	...	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	57	34	45.5
14	86	82	84	...	...	...	4	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	54	42	48
15	86	84	85	...	...	...	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	52	43	47.5
16	86	78	82	...	...	...	2	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	58	44	51
17	79	67	73	...	...	...	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	66	56	61
18	77	68	72.5	...	...	...	1	1	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	64	54	59
19	72	68	70	...	...	...	1	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	64	58	61
20	74	69	71.5	...	...	...	2	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	64	55	59.5
21	78	73	75.5	...	...	...	2	3	3	B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	70	58	64
22	77	75	76	...	...	...	3	4	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	61	56	58.5
23	82	78	80	...	...	...	2	4	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	62	54	58
24	85	76	80.5	...	...	...	D	4	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	65	55	60
25	86	78	82	...	...	...	...	4	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	63	58	60.5
26	88	84	86	...	...	...	...	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	61	55	58
27	88	83	85.5	...	...	...	...	D	3	3	B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	58	49	53.5
28	86	82	84	...	...	...	...	...	3	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	59	42	50.5
29	88	84	86	...	...	...	...	...	4	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	52	40	46
30	89	85	87	...	...	...	...	...	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	54	40	47
31	90	84	87	...	...	...	...	...	3	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	53	42	47.5
June 1	90	85	87.5	...	...	...	...	...	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	53	44	48.5
2	90	84	87	...	...	...	...	...	D	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	54	43	48.5
3	91	83	87	...	...	...	...	...	...	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	52	46	49
4	90	85	87.5	...	...	...	...	...	...	4	3	B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	54	44	49
5	89	85	86.5	...	...	...	...	...	...	4	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	51	45	48
6	92	88	90	...	...	...	...	...	...	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	51	40	45.5

B, born; D, died.

Table 1. Generation Series—Continued.

Date.	Temperature			7th G.	8th G.	9th G.	10th G.	11th G.	12th G.	13th G.	14th G.	15th G.	16th G.	17th G.	18th G.	19th G.	20th G.	21st G.	22nd G.	23rd G.	24th G.	25th G.	26th G.	27th G.	28th G.	29th G.	30th G.	31st G.	Humidity		
	Max.	Min.	Mean																										Max.	Min.	Mean
1916																															
June 7	90	81	85.5	2	2																								51	45	48
8	85	72	78.5	4	4	4	B																						65	45	55
9	84	78	81	5	6	5																							55	41	48
10	86	80	83	6	6	6																							56	46	51
11	88	82	85	7	7	7																							60	46	53
12	89	78	83.5	8	8	8																							70	47	58.5
13	88	80	84	8	8	8	4	B																					66	48	57
14	88	84	86	7	7	8	6																						60	48	54
15	87	80	83.5	6	8	7	8																						58	58	54
16	84	77	80.5	6	7	6	12																						56	49	52.5
17	86	83	84.5	5	4	5	7	3	B																				53	40	56.5
18	84	79	81.5	4	3	4	7	4																					62	47	54.5
19	88	78	83	2	4	3	4	7																					60	40	50
20	90	79	84.5	2	2	0	6	7																					63	41	52
21	91	81	86	2	9	1	5	5																					62	41	51.5
22	92	85	88.5	1	3	2	5	4	3	B																			62	43	52.5
23	90	85	87.5	1	7	1	2	0	7																				62	52	57
24	91	86	88.5	0	0	0	3	L	10																				60	46	53
25	91	86	88.5	0	1	0	3		10																				65	42	53.5
26	92	90	91	2	3	D	3		7																				51	43	47
27	93	90	91.5	D	4		0		6																				49	39	44
28	92	85	88.5		1		3		5																				50	41	45.5
29	91	81	86		0		0		2	5	B																		53	45	49
30	90	81	85.5		2		1		2	3																			61	58	55.5
July 1	97	82	89.5		1		2		5	3																			58	52	55
2	92	84	88		0		2		5	3																			62	53	57.5
3	94	85	89.5		6		D		3	2																			54	51	52.5
4	89	81	85		D				6	2																			75	61	68
5	89	83	86						2	2																			75	63	69
6	90	77	83.5						2	3	2	B																	75	62	68.5
7	96	80	88						0	0	4																		70	53	61.5
8	98	88	93						1	1	10																		67	49	58
9	97	86	91.5						D	D	10																		66	46	56
10	95	90	92.5								5																		64	40	52
11	96	85	90.5								8	4	B																74	49	61.5
12	94	88	91								5	6																	73	53	63
13	95	86	90.5								5	6																	72	54	63

B, born; L, Lost.

Table 1. Generation Series—Continued

Date	Temperature			14th G.	15th G.	16th G.	17th G.	18th G.	19th G.	20th G.	21st G.	22nd G.	23rd G.	24th G.	25th G.	26th G.	27th G.	28th G.	29th G.	30th G.	31st. G.	32nd G.	33rd G.	34th G.	35th G.	36th G.	37th G.	38th G.	39th G.	Humidity		
	Max.	Min.	Mean																											Max.	Min.	Mean
1916																																
July 14	91	87	89	4	7																									72	62	67
15	93	86	89.5	6	7																									77	55	66
16	95	85	90	6	6	5	B																							75	53	64
17	95	85	90	3	3	7																								70	50	60
18	96	92	94	8	6	8																								68	50	59
19	94	88	91	2	3	9																								67	58	62.5
20	95	87	91	2	8	7	2	B																						71	50	60.5
21	95	88	91.5	1	6	8	8																							85	55	70
22	90	80	85	3	D	3	8																							80	67	73.5
23	91	86	88.5	D		3	8																							73	66	69.5
24	92	90	91			1	7																							72	30	51
25	100	74	87			1	10	10	B																					91	34	62.5
26	96	73	84.5			6	5	9																						98	51	74.5
27	93	74	83.5			1	4	6																						97	49	78
28	97	75	86			D	10	5																						96	47	71.5
29	98	74	86				4	5	6	B																				93	40	66.5
30	88	73	80.5				4	5	6																					97	60	78.5
31	95	73	84				5	7	12																					95	40	67.5
Aug. 1	97	74	85.5				2	3	4																					96	37	66.5
2	99	75	87				2	D	3																					96	38	67.
3	99	75	87				3		6	3	B																			99	38	68.5
4	97	73	90				0		12	9																				97	40	68.5
5	98	75	91.5				7		2	10																				95	40	67.5
6	81	75	78				7		2	10																				95	76	85.5
7	95	73	84				4		3	2																				95	50	72.5
8	89	72	80.5				4		3	1	4	B																		95	63	84
9	94	75	84.5				9		4	3	6																			96	46	71
10	94	75	84.5				11		4	6	7																			96	43	69.5
11	95	75	85				8		1	1	11																			96	48	72
12	98	74	86				6		1	4	4																			96	45	70.5
13	98	73	85.5				5		1	4	4																			96	39	67.5
14	98	75	86.5				1		1	4	4																			95	37	66
15	97	74	85.5				3		0	4	0	3	B																	97	40	68.5
16	99	72	85.5				D		0	1	1	2																		99	41	70
17	95	68	81.5						0	3	2	10																		99	52	75.5
18	97	74	85.5						D	4	2	10	1	B																96	46	71
19	96	77	86.5							2	3	3	3																	90	47	68.5
20	97	72	84.5							4	3	4	4																	100	46	73

B, born. D, died.

Table 1. Generation Series—Continued

Date	Temperature			20th G.	21st G.	22nd G.	23rd G.	24th G.	25th G.	26th G.	27th G.	28th G.	29th G.	30th G.	31st G.	32nd G.	33rd G.	34th G.	35th G.	36th G.	37th G.	38th G.	39th G.	40th G.	41st G.	42nd G.	43rd G.	44th G.	45th G.	Humidity		
	Max.	Min.	Mean																											Max.	Min.	Mean
1916																																
Aug. 21...	98	74	86	D	3	5	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	91	35	63
22...	99	73	86	...	3	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	99	42	70.5
23...	98	75	86.5	...	3	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	99	43	71
24...	91	76	83.5	...	5	5	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	94	53	63.5
25...	93	68	80.5	...	5	5	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	96	46	71
26...	95	68	81.5	...	2	3	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	90	32	61
27...	96	68	82.5	...	3	2	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100	30	65
28...	95	75	85	...	2	2	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100	45	72.5
29...	96	74	85	...	2	2	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100	41	70.5
30...	95	73	84	...	2	2	3	2	B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	99	40	69.5
31...	95	75	85	...	2	2	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	99	41	70
Sept. 1...	95	76	85.5	...	2	2	3	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	98	48	73
2...	97	75	86	...	D	2	5	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	99	43	71
3...	97	74	85.5	...	...	2	5	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	97	38	67.5
4...	98	74	86	...	...	0	4	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	98	38	68
5...	98	76	87	...	...	D	3	3	2	B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	99	40	69
6...	97	76	86.5	...	...	...	3	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	99	38	68.5
7...	98	75	86.5	...	...	...	2	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	98	39	68.5
8...	99	76	87.5	...	...	...	2	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	98	40	68.5
9...	101	75	88	...	...	...	2	3	3	3	B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	99	38	68.5
10...	95	78	86.5	...	...	...	2	3	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	97	50	73.5
11...	95	75	85	...	...	...	2	3	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100	48	74
12...	98	76	87	...	...	...	2	2	3	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	99	41	70
13...	98	74	86	...	...	...	D	2	3	3	3	B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	98	39	68.5
14...	93	75	84	...	...	...	...	3	4	4	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100	48	74
15...	91	74	87.5	...	...	...	...	2	3	4	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	87	45	66
16...	87	66	76.5	...	...	...	...	2	3	4	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	87	43	65
17...	85	67	76	...	...	...	...	2	2	4	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	74	36	55
18...	89	63	76	...	...	...	...	0	3	4	4	3	B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	79	28	53.5
19...	87	65	76	...	...	...	...	D	3	4	4	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100	40	70
20...	90	66	78	...	...	...	...	...	4	5	4	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100	38	69
21...	90	61	75.5	...	...	...	...	...	4	4	3	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	99	40	64.5
22...	94	65	74.5	...	...	...	...	...	3	3	2	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	89	20	54.5
23...	92	68	85	...	...	...	...	...	3	3	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	85	37	61
24...	95	68	86.5	...	...	...	...	...	2	3	3	3	4	B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100	42	71
25...	93	68	80.5	...	...	...	...	...	2	3	3	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100	42	71
26...	79	69	74	...	...	...	...	...	D	3	3	3	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100	70	85
27...	90	73	81.5	...	...	...	...	...	...	2	2	3	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	99	49	74

B, born; D, died.

Table 1. Generation Series—Continued

Date.	Temperature Max.	Temperature Min.	Temperature Mean	26th G.	27th G.	28th G.	29th G.	30th G.	31st G.	32nd G.	33rd G.	34th G.	35th G.	36th G.	37th G.	38th G.	39th G.	40th G.	41st G.	42nd G.	43rd G.	44th G.	45th G.	46th G.	47th G.	48th G.	49th G.	50th G.	51st G.	Humidity Max.	Humidity Min.	Humidity Mean
1916																																
Sept. 28...	94	76	85	2	2	3	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	99	38	68.5
29...	85	54	69	2	2	2	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	78	37	57.5
30...	76	46	61	2	4	2	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	81	23	52
Oct. 1...	78	49	63.5	2	4	1	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	96	27	61.5
2...	82	56	69	2	3	2	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	99	28	63.5
3...	92	63	77.5	3	3	3	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	82	29	55.5
4...	93	63	78	2	3	3	3	3	B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	94	29	61.5
5...	94	66	80	1	3	2	2	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100	33	66.5
6...	94	65	79.5	0	3	3	4	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100	25	62.5
7...	94	65	79.5	D	3	3	4	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100	28	64
8...	94	70	82	...	3	4	5	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	100	31	65.5
9...	94	70	82	...	3	4	5	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	99	36	62.5
10...	91	70	80.5	...	3	5	5	5	5	B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	79	47	63
11...	88	62	75	...	0	6	5	5	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	80	48	64
12...	86	61	73.5	...	3	6	9	3	9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	99	47	73
13...	88	71	79.5	...	2	6	5	5	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	102	45	73.5
14...	91	68	79.5	...	1	7	5	5	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	101	46	73.5
15...	90	67	78.5	...	0	7	5	5	6	7	B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	101	43	72
16...	88	68	78	...	0	5	6	5	6	10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	101	42	71.5
17...	82	65	73.5	...	0	5	4	3	4	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	101	62	81.5
18...	71	60	65.5	...	0	2	3	2	3	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	101	78	89.5
19...	73	59	66	...	0	2	2	4	3	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	98	60	79
20...	81	38	59.5	...	0	0	1	2	2	2	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	77	51	64
21...	62	38	50	...	0	0	2	2	3	0	2	B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	95	28	61.5
22...	70	43	56.5	...	0	4	3	6	2	6	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	96	28	62
23...	76	56	66	...	0	3	2	4	4	4	3	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	101	43	72
24...	...	...	...	...	D	4	3	4	3	5	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
25...	...	...	...	...	...	0	3	4	3	5	6	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
26...	...	...	...	...	...	1	0	3	1	1	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
27...	...	...	...	...	...	0	1	1	4	4	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
28...	...	...	...	...	...	0	1	2	4	4	5	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
29...	...	...	...	...	...	0	1	1	0	4	7	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
30...	...	...	...	...	...	0	0	0	1	6	10	10	B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
31...	...	...	...	...	...	0	0	1	0	5	6	7	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
Nov. 1...	...	...	...	...	...	0	1	0	0	1	4	4	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2...	...	...	...	...	...	0	0	0	0	3	4	9	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3...	...	...	...	...	...	0	0	1	0	1	5	8	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4...	...	...	...	...	...	0	0	0	0	3	3	10	9	B	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...

B, born; D, died.

Table 1. Generation Series—Continued

Date	Temperature			28th G.	29th G.	30th G.	31st G.	32nd G.	33rd G.	34th G.	35th G.	36th G.	37th G.	38th G.	39th G.	40th G.	41st G.	42nd G.	43rd G.	44th G.	45th G.	46th G.	47th G.	48th G.	49th G.	50th G.	51st G.	52nd G.	53rd G.	Humidity		
	Max.	Min.	Mean																											Max.	Min.	Mean
1916																																
Nov. 5				0	0	0	0	3	3	10	9																					
6				D	0	0	0	3	1	5	13																					
7					D	0	0	2	1	5	13																					
8						0	0	0	1	1	D																					
9						0	0	1	0	2																						
10						0	0	2	0	1																						
11						0	D	1	0	0		6	B																			
12						D		1	0	0		6																				
13								0	0	0		1																				
14								0	0	0		3																				
15								0	0	0		5																				
16								0	0	0		7																				
17								0	0	0		4																				
18								0	0	0		9																				
19								0	0	0		9																				
20								0	0	0		8	3	B																		
21								0	0	0		6	4																			
22								0	0	0		5	4																			
23								0	0	0		7	10																			
24								0	0	0		1	4																			
25								D	0	0		4	5																			
26									0	0		4	6																			
27									0	0		6	6																			
28									0	0		5	10	6	B																	
29									D	0		5	10	10																		
30										D		4	9	10																		
Dec. 1												3	6	6																		
2												3	6	11																		
3												2	6	11																		
4												2	5	8	10	B																
5												1	3	6	8																	
6												0	1	3	7																	
7												0	0	1	5																	
8												0	0	1	4																	
9												0	0	1	2																	
10												0	0	0	2																	
11												D	0	1	5																	
12													0	0	3																	

B, born; D, died.

Table 1. Generation Series—Continued.

Date	Temperature			37th G.	38th G.	39th G.	40th G.	41st G.	42nd G.	43rd G.	44th G.	45th G.	46th G.	47th G.	48th G.	49th G.	50th G.	51st G.	52nd G.	53rd G.	54th G.	55th G.	56th G.	57th G.	58th G.	59th G.	60th G.	61st G.	62nd G.	Humidity		
	Max.	Min.	Mean																											Max.	Min.	Mean
1916																																
Dec. 13				0	0	8	6	B																								
14				0	0	1	1																									
15				0	1	2	3																									
16				0	0	4	6																									
17				0	0	3	6																									
18				0	0	3	3																									
19				0	0	4	10																									
20				0	0	2	7																									
21				0	0	3	5	3	B																							
22				0	0	0	3	6																								
23				0	0	1	9	10																								
24				0	0	1	9	10																								
25				D	0	0	6	11																								
26					0	1	0	7	3	B																						
27					0	1	2	9	7																							
28					0	0	5	8	8																							
29					D	0	2	2	5																							
30						0	1	2	8																							
31						0	2	2	8																							
1917																																
Jan. 1						0	5	1	12	6	B																					
2						0	5	1	4	20																						
3						D	10	1	3	14																						
4							7	3	8	8																						
5							4	0	1	2																						
6							3	1	2	4																						
7							3	0	D	4	2	B																				
8							3	1		4	5																					
9							1	0		6	7																					
10							0	0		6	5																					
11							1	D		4	5																					
12							0			3	4																					
13							0			1	5																					
14							0			2	4																					
15							0			1	2																					
16	64	50	57				0			4	5																			63	49	56
17	68	48	58				0			4	7	4	B																	66	44	55
18	78	58	68				0			0	0	5																		62	43	52.5
19	88	59	73.5				0			5	6	9																		61	39	50

B, born; D, died.

Table 1. Generation Series—Continued

Date.	Temperature			40th G.	41st G.	42nd G.	43rd G.	44th G.	45th G.	46th G.	47th G.	48th G.	49th G.	50th G.	51st G.	52nd G.	53rd G.	54th G.	55th G.	56th G.	57th G.	58th G.	59th G.	60th G.	61st G.	62nd G.	63rd G.	64th G.	65th G.	Humidity		
	Max.	Min.	Mean																											Max.	Min.	Mean
1917																																
Jan. 20	87	64	75.5	0			5	10	10																					70	45	57.5
21	82	74	78	0			D	8	9																					71	49	60
22	90	58	74	0				4	3																					60	47	53.5
23	76	56	66	0				6	8																					59	39	49
24	85	62	78.5	0				7	9	9	B																			66	36	51
25	102	50	76	0				3	3	6																				62	35	48.5
26	95	49	72	0				4	4	5																				59	32	45.5
27	94	55	74.5	0				4	2	7																				72	30	51
28	82	63	72.5	0				4	5	10	3	B																		68	42	55
29	79	65	72	D				2	3	5	6																			67	54	60.5
30	105	68	86.5					0	6	3	6																			76	9	42.5
31	103	68	85.5					D	1	4	3																			76	42	59
Feb. 1	92	44	68						4	2	3																			...	...	...
2	80	46	63						3	3	5																			43	27	35
3	96	50	73						1	3	3																			48	32	40
4	76	56	66						3	1	3	4	B																	54	36	45
5	105	45	75						2	6	3	3																		49	23	36
6	95	62	78.5						3	4	4	8																		42	24	33
7	75	64	69.5						1	4	5	6																		62	42	52
8	77	62	69.5						1	5	3	8																		61	47	54
9	102	54	78						0	9	5	6	3	B																61	23	42
10	104	60	82						D	2	1	9	6																	63	23	43
11	105	64	84.5							2	0	7	9																	78	31	54.5
12	77	55	66							2	0	8	11																	68	34	51
13	80	65	72.5							3	D	7	11																	49	34	41.5
14	94	68	81							1		4	6																	75	36	55.5
15	97	53	75							1		2	9																	69	34	51.5
16	88	52	70							0		0	5	8	B															57	30	43.5
17	88	59	73.5							0		D	4	12																70	24	47
18	90	68	79							D			3	10																68	49	58.5
19	108	77	92.5										3	9																62	29	45.5
20	98	61	79.5										2	8	11	B														48	15	31.5
21	110	61	85.5										2	9	8															56	14	35
22	103	70	86.5										4	8	9															72	13	42.5
23	95	72	83.5										3	5	6															71	34	52.5
24	103	58	80.5										2	4	6															67	15	41
25	102	60	81										1	8	7															75	22	48.5
26	110	68	89										1	3	6	7	B													71	29	50

B, born; D, died.

Table 1. **Generation Series—Continued.**

Date	Temperature			49th G.	50th G.	51st G.	52nd G.	53rd G.	54th G.	55th G.	56th G.	57th G.	58th G.	59th G.	60th G.	Humidity		
	Max.	Min.	Mean													Max.	Min.	Mean
1917																		
Feb. 27	101	65	83	1	2	3	2									78	28	53
28	90	63	76	0	1	4	4									58	33	45.5
Mar. 1	93	54	78.5	2	2	4	4									74	27	50.5
2	68	55	61.5	0	0	3	4									65	53	59
3	67	51	59	D	1	2	3	2	B							65	57	61
4	65	47	56		0	4	3	3								63	46	54.5
5	91	45	68		1	2	2	6								54	25	39.5
6	91	54	72.5		2	1	4	5								63	25	44
7	91	62	76.5		3	2	3	7								72	42	57
8	91	52	71.5		1	0	2	4								59	41	50
9	90	56	73		0	3	3	8	5	B						67	25	46
10	76	61	68.5		0	2	3	9	6							79	49	64
11	92	66	79		D	0	1	9	15							77	34	55.5
12	82	67	74.5			0	1	3	10							78	44	61
13	82	69	75.5			4	2	10	7							75	45	60
14	88	52	70			1	0	10	10							66	15	40.5
15	92	56	74			0	2	3	3							80	13	46.5
16	94	63	78.5			0	0	3	2	6	B					75	30	52.5
17	73	46	59.5			0	0	3	2	8						62	30	46
18	94	45	69.5			D	0	2	2	10						63	14	38.5
19	85	54	69.5				1	6	7	7						63	6	34.5
20	71	59	65				0	2	3	11						71	59	65
21	81	68	74.5				0	5	1	11						74	45	59.5
22	96	69	82.5				0	2	1	2						79	28	53.5
23	91	70	80.5				0	1	1	2						73	31	52
24	79	49	64				1	0	3	11	6	B				63	21	42
25	94	52	73				1	0	4	10	6					67	6	36.5
26	92	62	77				0	1	0	3	9					78	9	43.5
27	92	52	72				D	0	0	2	7					52	14	33
28	90	47	68.5					1	2	4	5					57	7	32
29	88	53	70.5					0	1	4	5					71	10	40.5
30	91	66	78.5					1	0	2	10	5	B			78	29	53.5
31	92	70	81					0	0	1	10	5				73	28	50.5
April 1	87	64	75.5					0	0	1	4	7				74	36	55
2	90	53	71.5					0	0	2	3	7				65	1	33
3	95	47	71					4	0	4	5	7				68	15	41.5
4	86	60	73					4	0	3	6	8				79	16	47.5
5	72	49	60.5					2	0	2	4	6				66	28	47

B, born; D, died.

Table 1. Generation Series—Continued

Date.	Temperature			53rd G.	54th G.	55th G.	56th G.	57th G.	58th G.	59th G.	60th G.	61st G.	62nd G.	Humidity		
	Max.	Min.	Mean											Max.	Min.	Mean
1917																
April 6...	78	48	63	2	0	1	11	5	...	...	...	...	...	68	17	42.5
7...	75	54	64.5	D	0	3	8	7	...	...	...	...	...	78	22	50
8...	74	51	62.5	...	0	2	8	6	3	B	...	...	...	68	16	42
9...	67	44	55.5	...	0	2	4	D	4	...	...	...	...	72	32	52
10...	70	51	60.5	...	0	2	8	...	5	...	...	...	...	80	25	52.5
11...	74	58	66	...	0	1	9	...	5	...	...	...	...	73	38	55.5
12...	77	60	68.5	...	0	1	5	...	4	...	...	...	...	84	47	60.5
13...	78	55	66.5	...	D	0	5	...	4	...	...	...	...	73	32	52.5
14...	73	53	63	...	...	1	4	...	0	...	...	...	...	76	37	56.5
15...	77	53	65	...	...	1	4	...	7	...	...	...	...	78	28	53
16...	79	58	68.5	...	...	1	3	...	7	7	B	...	...	77	30	53.5
17...	81	70	75.5	...	...	0	2	...	6	10	...	...	...	79	45	62
18...	80	68	74	...	...	D	1	...	5	10	...	...	...	79	52	65.5
19...	83	70	66.5	...	...	...	1	...	4	9	...	...	...	78	45	61.5
20...	79	62	70.5	...	...	...	1	...	8	6	...	...	...	79	54	66.5
21...	70	52	61	...	...	...	0	...	5	11	...	...	...	71	26	48.5
22...	82	54	68	...	...	...	0	...	4	11	3	B	...	73	14	43.5
23...	83	56	69.5	...	...	...	0	...	3	11	13	...	...	72	12	42
24...	86	60	73	...	...	...	0	...	3	4	10	...	...	75	15	45
25...	83	63	73	...	...	...	0	...	3	4	10	...	...	80	30	55
26...	84	64	74	...	...	...	0	...	D	3	...	1	...	78	35	56.5
27...	83	63	73	...	...	...	0	...	...	...	...	3	...	74	29	51.5

B, born; D, died.

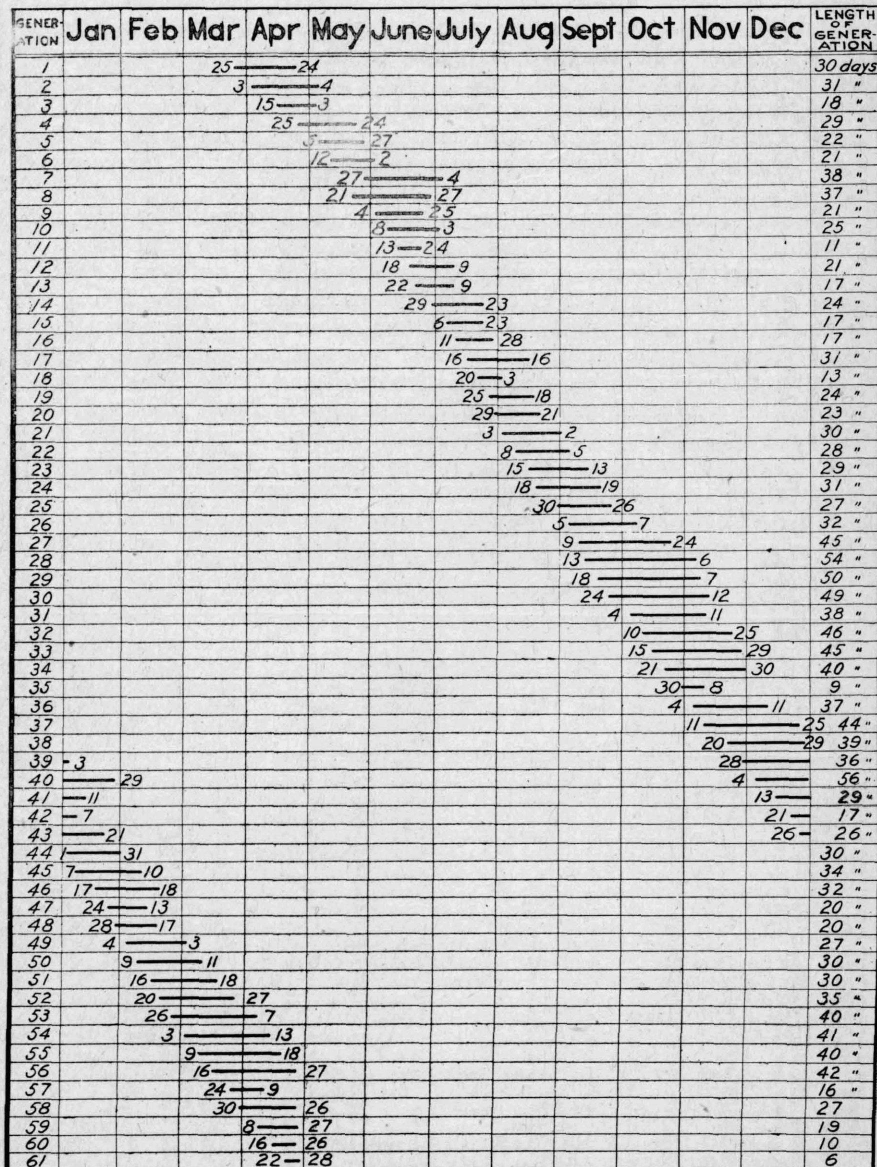

Figure 3. Succession of Generations in Cotton or Melon Louse

Number of Generations.

On March 25, 1916, a study was started on the number of successive generations of this species, and this work was continued for exactly one year without a break. For this work cotton was used for the host; and it is well that this selection was made, for the species will not persist well on any other host for an entire year. The cotton plant will withstand more unfavorable conditions than any of the other hosts, and the infestation was maintained with ease on cotton in the insectary for months when the host was not present in the fields, that is, from November to April.

No sex forms ever appeared on the plants in the cages. In only one generation, the third, did an alate female develop in the cage.

The generation series given in Table I is of the first born individuals, and consequently it gives only the maximum number of generations that may occur in the period of twelve months. There will naturally be a variation in the number of generations, even in the same locality, from year to year, as climatic conditions vary. These experiments were conducted out of doors during the period that was free from killing frosts,—March 15 to November 1. During the remainder of the year the cages were maintained in the insectary. The conditions of temperature and humidity were recorded by the hygro-thermograph. In the period of exactly one year, fifty-seven generations were born. In this same period, fifty-one generations completed their life cycle.

Table 2. Line of Generation

Date of Birth	Date of First Born	Age, Days	Date of Last Young	Reproduction Period Days	Total Young	Average per Day	Maximum per Day	Date of Death	Total Days of Generation.
Mar. 25.....	April 3...	9	April 23...	20	75	3.7+	12	April 24...	30
April 3.....	April 15...	12	May 3...	18	62	3.4+	4	May 4...	31
April 15.....	April 25†..	10	May 2...	7	17	2.4+	3	May 3...	18
April 25.....	May 5...	10	May 23...	18	51	2.8+	4	May 24...	29
May 5.....	May 12...	7	May 26...	14	46	3.2+	4	May 27...	22
May 12.....	May 21...	10	June 1...	11	40	3.6+	4	June 2...	21
May 27.....	June 4...	8	July 3...	29	146	5.0	9	July 4...	38
May 21.....	May 27...	6	June 26...	30	117	3.9+	8	June 27...	37
June 4.....	June 8...	4	June 25...	17	75	4.4+	8	June 25...	21
June 8.....	June 13...	5	July 2...	19	101	5.3+	12	July 3...	25
June 13.....	June 17*..	4	June 23...	6	30	5.0	7	June 24...	11*
June 18.....	June 22...	4	July 8...	16	76	4.7+	10	July 9...	21
June 22.....	June 29...	7	July 8...	9	24	2.7+	5	July 9...	24
June 29.....	July 6...	7	July 22...	16	49	3.0	10	July 23...	26
July 6.....	July 11...	5	July 22...	11	51	4.6+	8	July 23...	17
July 11.....	July 16...	5	July 27...	11	59	5.3+	9	July 28...	17
July 16.....	July 20...	4	Aug. 15...	26	138	5.3+	11	Aug. 16...	31
July 20.....	July 25...	5	Aug. 1...	7	45	6.4+	10	Aug. 3...	13
July 25.....	July 29...	4	Aug. 17...	19	71	3.6+	12	Aug. 18...	24
July 29.....	Aug. 3...	5	Aug. 20...	17	75	4.4+	10	Aug. 21...	23
Aug. 3.....	Aug. 8...	5	Sept. 1...	24	85	3.5+	11	Sept. 2...	30
Aug. 8.....	Aug. 15...	7	Sept. 4...	20	72	3.6+	10	Sept. 5...	28
Aug. 15.....	Aug. 18...	3	Sept. 12...	25	84	3.4+	6	Sept. 13...	29
Aug. 18.....	Aug. 30...	12	Sept. 18...	19	54	2.3+	4	Sept. 19...	31
Aug. 30.....	Sept. 5...	6	Sept. 25...	20	62	3.1+	4	Sept. 26...	27
Sept. 5.....	Sept. 9...	4	Oct. 6...	28	80	2.2+	5	Oct. 7...	32
Sept. 9.....	Sept. 13...	4	Oct. 23...	41	94	2.2+	5	Oct. 24...	45
Sept. 13.....	Sept. 18...	5	Oct. 26...	38	132	3.4+	9	Nov. 6...	54
Sept. 18.....	Sept. 24...	6	Nov. 1...	37	129	3.4+	9	Nov. 7...	50
Sept. 24.....	Oct. 4...	10	Nov. 3...	30	96	3.2+	6	Nov. 12...	49
Oct. 4.....	Oct. 10...	6	Oct. 30...	20	89	4.4+	10	Nov. 11...	38
Oct. 10.....	Oct. 15...	5	Nov. 12...	28	99	3.5+	10	Nov. 25...	46
Oct. 15.....	Oct. 21...	6	Nov. 8...	18	80	3.3+	10	Nov. 29...	45
Oct. 21.....	Oct. 30...	9	Nov. 10...	11	72	6.5+	10	Nov. 30...	40

Table 2.—Line of Generations—Continued.

Date of Birth	Date of First Born	Age, Days	Date of Last Young	Reproduction Period Days	Total Young	Average per Day	Maximum per Day	Date of Death	Total Days of Generation
Oct. 30.....	Nov. 4*..	4	Nov. 7...	3	44	14	13	Nov. 8...	9*
Nov. 4.....	Nov. 11...	7	Dec. 5...	24	116	4.5+	9	Dec. 11...	37
Nov. 11.....	Nov. 20...	9	Dec. 6...	16	98	6.1+	10	Dec. 25...	43
Nov. 20.....	Nov. 28...	8	Dec. 15...	17	76	4.4+	11	Dec. 29...	39
Nov. 28.....	Dec. 4...	6	Dec. 27...	23	80	3.4+	10	Jan. 3...	36
Dec. 4.....	Dec. 13...	9	Jan. 11...	29	126	4.3+	10	Jan. 29...	56
Dec. 13.....	Dec. 21...	8	Jan. 8...	18	68	3.7+	11	Jan. 11...	29
Dec. 21.....	Dec. 26*..	5	Jan. 6...	11	69	5.9+	12	Jan. 7...	17*
Dec. 26.....	Jan. 1*..	6	Jan. 20...	18	103	5.7+	20	Jan. 21...	26*
Jan. 1.....	Jan. 7...	6	Jan. 29...	27	105	3.8+	10	Jan. 31...	30
Jan. 7.....	Jan. 17*..	10	Feb. 8...	22	99	4.4+	10	Feb. 10...	34*
Jan. 17.....	Jan. 24...	7	Feb. 15...	22	97	4.4+	10	Feb. 18...	31
Jan. 24.....	Jan. 28...	4	Feb. 10...	13	53	4.0	6	Feb. 13...	20
Jan. 28.....	Feb. 4*..	7	Feb. 15...	11	52	4.7+	9	Feb. 17...	20*
Feb. 4.....	Feb. 9...	5	Mar. 1...	20	95	3.7+	11	Mar. 3...	27
Feb. 9.....	Feb. 16...	7	Mar. 8...	20	97	4.8+	12	Mar. 11...	30
Feb. 16.....	Feb. 20...	4	Mar. 14...	22	88	4.0	11	Mar. 18...	30
Feb. 20.....	Feb. 26...	6	Mar. 25...	27	53	1.8+	7	Mar. 27...	35
Feb. 26.....	Mar. 3...	5	April 6...	29	114	3.4+	10	April 7...	40
Mar. 3.....	Mar. 9...	6	Mar. 29...	20	86	4.3+	15	April 13...	41
Mar. 9.....	Mar. 16...	7	April 16...	31	114	3.5+	11	April 18...	40
Mar. 16.....	Mar. 24...	8	April 20...	27	154	5.6+	11	April 27...	42
Mar. 24.....	Mar. 30*..	6	April 8...	9	63	7.0	8	April 9...	16*
Mar. 30.....	April 8...	9	April 25...	17	90	5.2+	7	April 26...	27
April 8.....	April 16...	8	April 26...	10	86	8.6+	11	April 27...	19
April 16.....	April 22*..	6	April 25...	3	36	12.0	13	April 26...	10*
April 22.....	April 26*..	4	April 27...	1	4	4.0	3	April 28...	6*

†—Alate female. *—Incomplete record.

Table 3.—Age at which Females begin Reproducing.

Date of Birth	Date of First Born	Period, Days	Mean Temp.	Mean Hum.
1916				
Mar. 25................	April 3................	9	73.0	50.1
April 3................	April 15................	12	77.4	54.2
April 15................	April 25................	10	84.4	52.8
April 25................	May 5................	10	79.4	53.3
May 5................	May 12................	7	91.0	58.7
May 12................	May 21................	10	77.8	50.3
May 21................	May 27................	6	94.2	68.7
May 27................	June 4................	8	78.0	44.8
June 4................	June 8................	4	87.3	47.6
June 8................	June 13................	5	85.5	53.1
June 13................	June 17................	4	83.5	54.3
June 18................	June 22................	4	83.7	52.0
June 22................	June 29................	7	89.1	50.3
June 29................	July 6................	7	87.0	59.3
July 6................	July 11................	5	89.7	59.2
July 11................	July 16................	5	90.1	64.1
July 16................	July 20................	4	91.0	61.3
July 20................	July 25................	5	89.4	64.9
July 25................	July 29................	4	85.2	71.6
July 29................	Aug. 3................	5	84.6	69.2
Aug. 3................	Aug. 8................	5	86.1	75.3
Aug. 8................	Aug. 15................	7	85.5	69.1
Aug. 15................	Aug. 18................	3	84.1	71.3
Aug. 18................	Aug. 30................	12	84.4	68.3
Aug. 30................	Sept. 5................	6	85.3	69.6
Sept. 5................	Sept. 9................	4	86.8	68.6
Sept. 9................	Sept. 13................	4	86.6	71.5
Sept. 13................	Sept. 18................	5	82.0	65.7
Sept. 18................	Sept. 24................	6	77.5	62.0
Sept. 24................	Oct. 4................	10	90.7	57.9
Oct. 4................	Oct. 10................	6	80.1	68.2
Oct. 10................	Oct. 15................	5	77.6	69.4
Oct. 15................	Oct. 21................	6	70.1	76.2
Oct. 21................	Oct. 30................	9	59.5	65.1
Oct. 30................	Nov. 4................	5	69.0	64.5
Nov. 4................	Nov. 11................	7	70.7	67.1

Table 3.—Age at which Females begin Reproducing—Continued.

Date of Birth	Date of First Born	Period, Days	Mean Temp.	Mean Hum.
1916				
Nov. 11	Nov. 20	9	53.4	67.6
Nov. 20	Nov. 28	8	56.0	72.7
Nov. 28	Dec. 4	6	63.7	65.2
Dec. 4	Dec. 13	9	58.8	60.7
Dec. 13	Dec. 21	8	52.2	64.5
Dec. 21	Dec. 26	5	47.8	62.5
Dec. 26	Jan. 1	6	59.4	62.8
1917				
Jan. 1	Jan. 7	6	63.6	72.7
Jan. 7	Jan. 17	10	59.0	54.0
Jan. 17	Jan. 24	7	70.4	53.9
Jan. 24	Jan. 28	4	75.2	48.0
Jan. 28	Feb. 4	7	74.3	48.5
Feb. 4	Feb. 9	5	71.7	44.0
Feb. 9	Feb. 16	7	59.8	48.4
Feb. 16	Feb. 20	4	78.7	48.6
Feb. 20	Feb. 26	6	82.7	41.1
Feb. 26	Mar. 3	5	77.6	51.6
Mar. 3	Mar. 9	6	67.2	51.0
Mar. 9	Mar. 16	7	73.7	73.3
Mar. 16	Mar. 24	8	61.1	50.0
Mar. 24	Mar. 30	6	70.8	37.8
Mar. 30	April 8	9	70.9	47.3
April 8	April 16	8	63.4	53.0
April 16	April 22	6	69.3	59.7
April 22	April 26	4	70.8	46.3

Age at Which Females Reproduce.

In Table 3 are given the records showing the age of each female observed when the first young was produced. This period varies with temperature and humidity conditions. In the table are given the mean temperature and the mean humidity for the period. A single high or a single low temperature may effect the duration of this period. The shortest period of three days occurred August 15 to 18, 1916, with a mean temperature of 84.1 degree F. and a mean humidity of 71.3 per cent. The period of four days occurred in ten generations with a mean temperature of 82.9 degrees F., and a mean humidity of 56.9 per cent. The longest period of 12 days occurred from April 3 to 15, 1916, with a mean temperature of 77.4 degrees F. and a mean humidity of 54.2 per cent, and again from August 18 to 30, 1916, with a mean temperature of 84.4 degrees F. and a mean humidity of 68.3 per cent.

Reproductive Period.

Climatic conditions exert as great an influence upon the length of the reproductive period as they do upon the other details of the aphid life history. The records made on this phase of the life history are shown in Table 4. The shortest period shown, 9 days, with a mean temperature of 85.9 degrees F. and a mean humidity of 59.6 per cent, is somewhat abnormal as the female reproduced only twenty young. The next shortest period, 11 days, occurred four times when the full period was observed. The mean temperature during these periods was 84.0 degrees F., and the mean humidity was 60.2 per cent. The average total young of these generations was 58.2, which is slightly below the average number of young produced. The longest reproductive period, 41 days, occurred from September 13 to October 23, 1916, with a mean temperature of 73.6 degrees F., and a mean humidity of 65.1 per cent. The total young produced by this generation was 94. The average reproduction period of all females observed in this work was 21.4 days.

Table 4.—Reproductive Period and Young Produced.

Date of First Born	Date of Last Young	Reproductive Period, Days	Mean Temp.	Mean Hum.	Generation	Total Young	Average Per Day
April 3........	April 23........	20	69.5	51.5	1	75	3.7
April 15........	May 3........	18	75.0	47.5	2	62	3.4
April 25........	May 2........	7†	73.3	47.0	3	17	2.4
May 5........	May 23........	18	82.8	51.8	4	51	2.8
May 12........	May 26........	14	78.0	53.9	5	46	3.2
May 21........	June 1........	11	82.6	54.6	6	40	3.6
June 4........	July 3........	29	88.2	51.9	7	146	5.0
May 27........	June 26........	30	85.2	51.4	8	117	3.9
June 8........	June 25........	17	83.9	53.8	9	75	4.4
June 13........	July 2........	19	86.1	52.4	10	101	5.3
June 17........	June 23........	6*	84.6	52.1	11	30	5.0
June 22........	July 8........	16	87.2	55.5	12	76	4.7
June 29........	July 8........	9	58.9	59.6	13	24	2.7
July 6........	July 22........	16	90.3	62.0	14	49	3.0
July 11........	July 22........	11	90.1	63.3	15	51	4.6
July 16........	July 27........	11	89.4	64.2	16	59	5.3
July 20........	Aug. 15........	26	78.9	64.0	17	138	5.3
July 25........	Aug. 1........	7	84.5	71.2	18	45	6.4
July 29........	Aug. 17........	19	76.4	65.8	19	71	3.6
Aug. 3........	Aug. 20........	17	75.4	62.4	20	75	4.4
Aug. 8........	Sept. 1........	24	77.5	63.5	21	85	3.5
Aug. 15........	Sept. 4........	20	84.5	69.2	22	72	3.6
Aug. 18........	Sept. 12........	25	85.2	69.2	23	84	3.4
Aug. 30........	Sept. 18........	19	89.9	65.3	24	54	2.3
Sept. 5........	Sept. 25........	20	82.7	66.6	25	62	3.1
Sept. 9........	Oct. 6........	28	79.4	63.3	26	80	2.2
Sept. 13........	Oct. 23........	41	73.6	65.1	27	94	2.2
Sept. 18........	Oct. 26........	38	70.3	63.5	28	132	3.4
Sept. 24........	Nov. 1........	37	73.6	68.0	29	129	3.4
Oct. 4........	Nov. 3........	30	73.0	69.1	30	96	3.2
Oct. 10........	Oct. 30........	20	70.1	71.4	31	89	4.4
Oct. 15........	Nov. 12........	28	66.0	65.7	32	99	3.5
Oct. 21........	Nov. 8........	18	67.3	64.8	33	80	3.3
Oct. 30........	Nov. 10........	11	65.4	60.7	34	72	6.5
Nov. 4........	Nov. 7........	3*	71.0	63.3	35	44	14.0
Nov. 11........	Dec. 5........	24	57.7	68.9	36	16	4.5
Nov. 20........	Dec. 6........	16	61.0	70.0	37	98	6.1
Nov. 28........	Dec. 15........	17	60.2	67.7	38	76	4.4
Dec. 4........	Dec. 27........	23	54.4	64.6	39	80	3.4
Dec. 13........	Jan. 11........	29	56.6	45.0	40	126	4.3
Dec. 21........	Jan. 8........	18	57.3	65.7	41	68	3.7
Dec. 26........	Jan. 6........	11*	68.0	68.8	42	69	5.9
1917							
Jan. 1........	Jan. 20........	18*	58.9	66.0	43	103	5.7
Jan. 7........	Jan. 29........	27	64.8	58.2	44	105	3.8
Jan. 17........	Feb. 8........	22*	72.4	46.8	45	99	4.4
Jan. 24........	Feb. 15........	22	74.7	45.2	46	97	4.4
Jan. 28........	Feb. 10........	13	73.6	42.5	47	53	4.0
Feb. 4........	Feb. 15........	11*	74.7	46.1	48	52	4.7
Feb. 9........	Mar. 1........	20	79.9	46.6	49	75	3.7
Feb. 16........	Mar. 8........	20	76.5	45.4	50	97	4.8
Feb. 20........	Mar. 14........	22	75.3	50.0	51	88	4.0
Feb. 26........	Mar. 25........	27	65.8	50.9	52	53	1.8
Mar. 3........	April 6........	29	87.1	56.6	53	114	3.4
Mar. 9........	Mar. 29........	20	72.4	48.1	54	86	4.3
Mar. 16........	April 16........	31	69.3	47.7	55	114	3.5
Mar. 24........	April 20........	27	68.7	43.8	56	154	5.6
Mar. 30........	April 8........	9*	70.9	47.2	57	63	7.0
April 8........	April 25........	17	66.7	53.6	58	90	5.2
April 16........	April 26........	10	69.9	54.3	59	86	8.6
April 22........	April 25........	3*	70.1	43.5	60	36	1.2
April 26........	April 27........	1*	74.5	56.5	61	4	4.0

†—Alate female. *—Incomplete record.

Total Young Produced.

The number of young produced varies greatly with the generation. The greatest number of young produced by one female was 154, over a period of 29 days. The mean temperature of this period was 68.7 degrees F., and the mean humidity was 43.8 per cent. The least number of young produced by a single female was 24, during a period of 9 days. The mean temperature of this period was 85.9 degrees F., and the mean humidity was 59.6 per cent. It cannot be said that the total number of young produced is less with lower temperatures, for examples taken from the table show that there is no correlation. For instance, the seventeenth generation produced with a mean temperature of 78.9 degrees 138 young, while the succeeding generation produced, with a mean temperature of 84.5 degrees F., only 45 young. Again, in the twenty-seventh and twenty-eighth generations the number of young produced was high, with a mean temperature of 70.3 and 73.6 degrees F., respectively. In the fifteenth and sixteenth generations the number of young produced was very low, but the mean temperature was 90.7 and 89.4 degrees F., respectively. Furthermore, the high temperatures do not reduce the number of young produced. The average number of young produced by a female, of the individuals observed in this work, was 84.4.

Average Number of Young Daily.

As shown in Table 4, the average number of young produced is not apparently controlled by any of the factors recorded. There is no correlation of this number with the total young produced or the length of the reproductive period. For instance, in the sixteenth and seventeenth generations the average young produced daily is the same; whereas the total young produced approach both extremes. Again the least average did not occur with the shortest period of reproduction or the smallest total young produced.

The average number of young produced daily, according to months, show smaller numbers in August, September, and in May. Here again there is an absence of any positive correlation of this number with the other factors recorded. These results are shown in Table 5.

Table 5.—Average Young Produced Daily.

Month	Young	Mean Temperature	Mean Humidity
1916			
April	3.0	73.3	48.3
May	2.7	79.2	52.9
June	4.4	85.7	51.4
July	4.7	89.5	62.0
August	2.8	85.3	76.8
September	2.3	78.8	67.3
October	4.3	72.6	67.7
November	4.4	60.7	68.1
December	5.6	55.8	63.9
1917			
January	4.6	66.2	60.6
February	4.5	76.8	43.8
March	3.7	79.3	49.1
April	3.9	68.8	52.6

Longevity.

In Table 2 is shown the length of each generation observed. The longest period consumed by a single generation was 56 days, from December 4, 1916, to January 29, 1917. The shortest period was 13 days, from July 20, 1916, to August 3, 1916. The number of young produced by this generation was the least of any of the apterous females. The average longevity of adult life of all the generations observed was 32.1 days.

Rate of Increase.

A reference to the average number of young produced, the average reproductive period, and the average longevity, will enable one to gain an idea of how readily this species may increase. The average period of maturity was 6.5 days, and an average number of 84.4 young were produced over an average period of 21.4 days.

Effect of Temperature on Development.

This species is susceptible to the effects of temperature during all stages of its life history. The effects of the low temperatures could not be determined for this species, as it has been done for other series, for during the coldest portions of the year the generation-series work was conducted in the insectary. During the spring and the fall months, when daily temperatures fluctuate, there was a corresponding change in the daily young produced. Also, low temperatures during a twenty-four hour period had more effect on the daily young produced than did the high temperature of the same period.

In the cages of the generation-series experiments, temperature did not affect the development of alate females. As only one alate female developed in the series, it is impossible to discuss the factors influencing the development of such forms.

During the warmest period of the year the development of all stages is retarded. It is very evident that the maximum temperature conditions are not the optimum conditions for the life activities. The period of extereme high temperature usually extends throughout the months of August and September. Reference to Table I will show that during this period the reproduction was less than during the preceding or succeeding months.

VIVIPAROUS DEVELOPMENT.

The normal form of reproduction in the cotton or melon louse in Texas is asexual throughout the entire year. At no time in cage studies or field observations, has a sex form of this insect been observed. Field observations were made on this plant louse within the extreme boundaries of the State. It is interesting that the sex forms of this species have never been found at any latitude in the United States.

SEASONAL HISTORY.

Detailed records were made on this insect at College Station during a period of two years. The experimental garden contained all the common host plants of this louse, and during the second season the common host plants were planted at successive dates. These studies were supplemented with field cages. During the later spring of 1916 the host plants were grown in the insectary, and these were left to natural infestation by released plant lice from the cages. Again, in the fall and early winter all these host plants were available in the insectary for natural infestation.

1916.

Insectary: As early as January 11 lice were noticed on seedling cotton which had but the second pair of leaves. This infestation was just starting; so most of the lice present were winged females. At this time some old watermelon vines were very heavily infested. This was unusual as there had been no heat in the insectary up to within a short time previous to this date. The winged females were present in great numbers on the watermelon. At this date seedling cucumbers were infested; the lice being on the growing tip and second leaves. This infestation was well established at that time. The infestation had just started on squash seedlings. A few days later an artificial transfer of lice from the heavy infestation on watermelon to cotton was attempted. For this purpose both the winged and the wingless forms were used, but the lice refused to colonize in both cases.

During the remainder of January and throughout February the infestation increased on cotton. The old watermelon vines were killed and on March 9 seedling plants were again available. However, these were not infested with lice. Muskmelon seedlings were also available at this time, but they were not infested. Cucumber plants which were growing adjacent to the melons were heavily infested. At this time a row of young okra plants was heavily infested.

Two weeks later the lice were very abundant on all cotton in the insectary. This infestation was made up of a large proportion of winged individuals. At this time an infestation was well established on watermelon seedlings but the muskmelon seedlings adjoining were not infested. The okra infestation continued very heavy. A large squash plant some distance from cotton was very heavily infested, and the plant died in a few days.

At the end of the next week the infestation on cotton had decreased slightly. On watermelon the infestation had increased, and the plants were about killed. The infestation was still very heavy on okra, but these plants seemed to be able to withstand the attack of a large number of lice. At this time lice were first observed in small numbers on cowpeas. On one eggplant three wingless lice were observed, but no young were found on this host at any time. In four days there were no lice on this host. One wingless and two winged lice were found on a sweet pepper plant. Two young ones were found on the following day, and these matured and reproduced. A week later the infestation was well established. However, most of the lice developed into the winged form and left the plant. Lice were observed on gourd, but the young present at this time did not mature and reproduce.

The observations in the insectary were closed on April 1. At this time the infestation on all hosts was decreasing, which fact was probably due to the poor growing condition of most of the plants. It was almost two months later when observations were begun in the field.

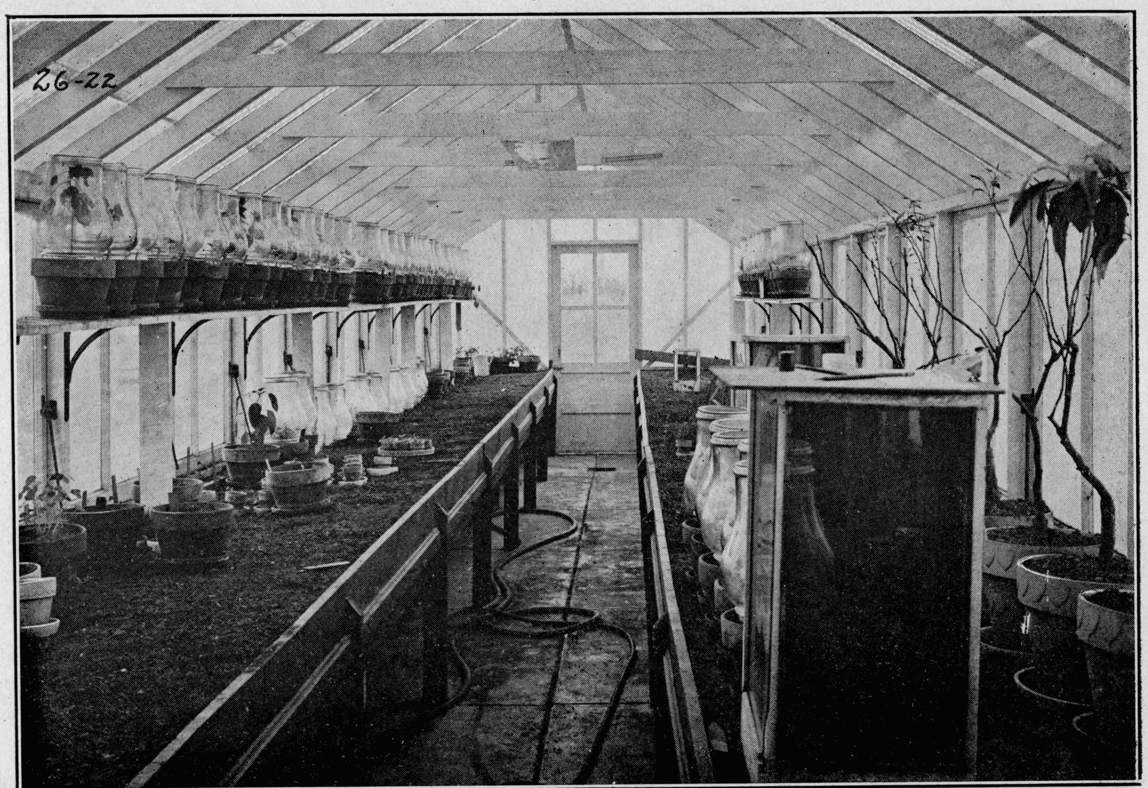

Plate II. Insectary.

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During this interval the lice were not observed on any weeds in the vicinity of the field or insectary.

Field: On May 24 lice were first observed on cotton that was from six to ten inches high. The infestation was well scattered and consisted of wingless lice. At this season the winged lice develop in a larger proportion than later; so that many plants are infested at about the same time. No lice were observed on watermelons which were growing adjacent to the cotton. The muskmelons were also not infested at this date. On the cucumbers the infestation was just starting. No infestation was found on okra, cowpea, squash, and pumpkin at this date, although these host plants were growing very close to the infested plants.

On the following day the infestation on cotton had increased materially. Still there was no infestation on watermelon and muskmelon. On cucumber the lice were not increasing. On one plant of okra there were a few immature lice.

The infestation continued to spread on cotton in the experimental garden. In the field the lice were just appearing on cotton on May 26 at which time the winged are abundant. The first lice were observed on watermelon on this date. This plant was only twelve feet from the first infested cotton. The infestation on cucumber did not increase at this time.

Five days later the infestation on cotton had increased so that the small leaves near the top of the plants were almost covered. The winged lice observed on watermelon previously did not start an infestation on this host. The infestation on cucumber was slight and well scattered. On okra the lice were well scattered and were not increasing rapidly. Lice were found on squash for the first time, on May 31, although this host had been growing in the adjoining row to cotton. Lice were present also on pumpkin for the first time.

Although infestation continued to increase on cotton, it remained well scattered on the plants over the field. A large proportion of winged lice existed through the infestation. On June 2 there were no lice on watermelon, muskmelon, or cucumber. At this time the okra was becoming heavily infested. On squash and pumpkin the lice increased, but were well scattered over the plants.

From June 5 the lice decreased on all the cotton in the cages, garden, and field. The same was true on watermelon, muskmelon, and cucumber. During this time the lice increased on okra, squash, and pumpkin. By the middle of June there were but few lice on cotton, and they were well scattered over the field. At this time the infestation on okra was decreasing, as was the case, on squash and pumpkins. Throughout the latter part of June the light scattered infestation persisted on cotton. During this period a few scattered lice were found on watermelon, muskmelon, and cucumber. The light scattered infestation persisted on squash and pumpkin.

During the first half of July the infestation increased slightly on cotton with a very large proportion of winged lice, which was probably to carry much of the infestation to another host plant. During this period a few lice persisted on watermelon, but a large proportion of them were the winged form. On muskmelons the infestation increased during this period to such an extent that a few plants were killed. Considerable damage was done to the cucumber plants by the increased infestation during this period. The infestation on okra was very light but persisted throughout this period. Lice were found on cowpeas for the first time during this period. This infestation was light and well scattered. The infestation on squash and pumpkin was very heavy, but was well scattered and consistent.

A light infestation of lice persisted on cotton throughout the last half of July. During this period the proportion of winged lice was very large. No lice were found on watermelon during this period, but many muskmelon vines were killed by the severe infestation. The infestation was heavy on cucumbers during this period. On squash and pumpkin the infestation gradually decreased.

During the first part of August the infestation on cotton increased slightly. The same was true on watermelon, muskmelon, and cucumber during this period and the plants died about the middle of August. Also the squash and pumpkin plants died, though not from the attack of the lice.

Observations during the first half of September showed a few lice on cotton in the field, and in the garden young cotton was more heavily infested than old cotton. At this time there were not many winged lice. The light scattered infestation persisted during the latter part of the month. During the month of October the infestation increased considerably, but it decreased during the first half of November. On November 13 a temperature of 28 degrees F. was recorded. Lice were found on the cotton on November 15, but from that date the lice disappeared rapidly from the field. At this time most of the lice developed into winged adults. Where cotton ground had been fall-plowed, the lice were found frequently on the exposed tips of the plants, and they persisted on these tips throughout November. On December 8 an examination was made in the field where the cotton stalks were allowed to remain standing. A few lice were found in the lower axils of the plant, in which location they were somewhat protected from the weather. There were some seedling plants in this field, and such plants were often infested with lice.

Insectary: In the early fall plantings were made in the insectary of the host plants of this louse. On November 7 lice were found on the young cotton plants that were just forming the second leaves. The watermelon plants were heavily infested with lice at this time, and a large proportion of winged lice developed. Young muskmelon plants were killed at this time by the severe infestation of lice. Cucumber plants were infested as early as the middle of October. This infestation increased very rapidly and all the plants were killed by November 7. Young plants coming up at this time were heavily infested. The okra was attacked heavily as soon as it came up. The infestation on squash and pumpkin started in October and did not increase rapidly until November 7. Cowpeas were planted next to squash, but the infestation on this host did not begin until the squash was heavily infested. A slight infestation occurred at this time on sweet peppers.

During the latter part of November the infestation increased on cotton, and many winged lice developed. By this time the watermelon,

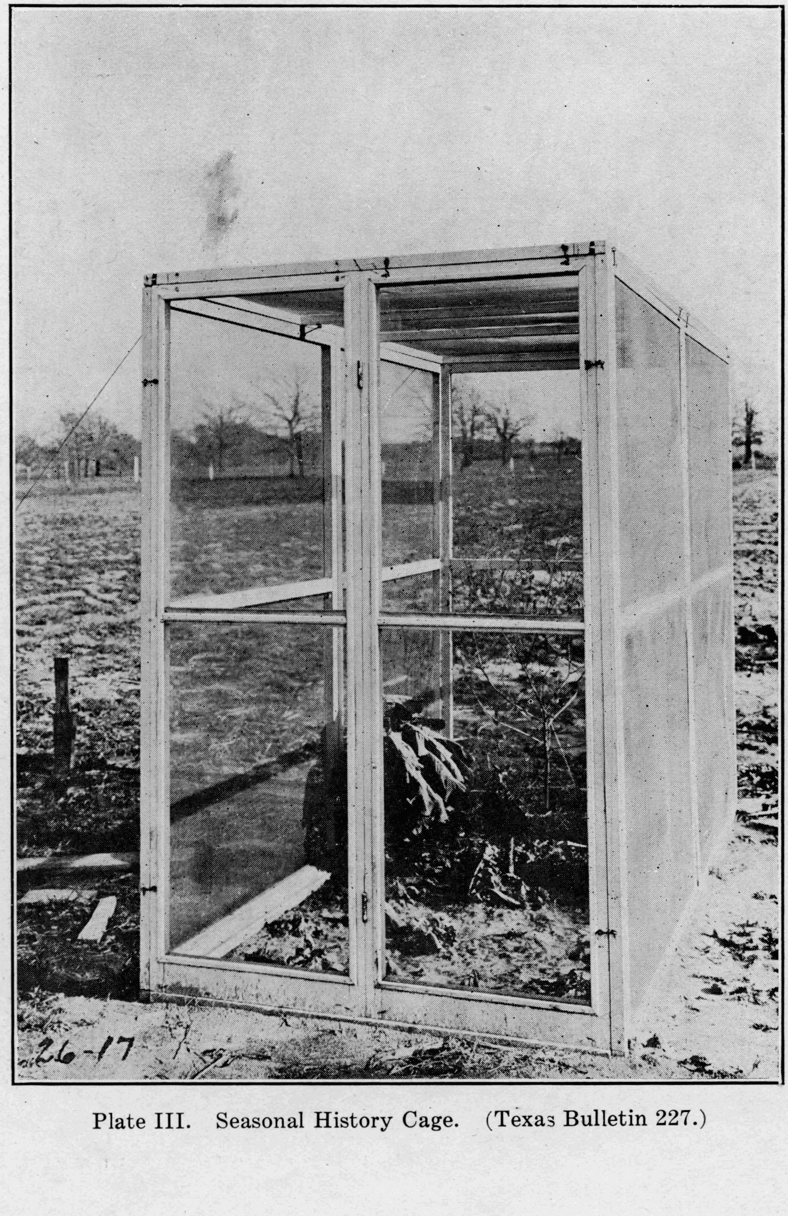

Plate III. Seasonal History Cage. (Texas Bulletin 227.)

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muskmelon, and cucumber plants were killed by the severe infestation. Small okra plants were heavily infested at this time. Squash and pumpkin plants were killed and seedlings were very heavily attacked at this time. Cowpeas were generally infested at this time. The lice were well colonized on sweet pepper at this time.

1917.

Field: On May 23, just one day earlier than last year, lice were present on cotton in the field. At this time the plants were very small; in most cases the second pair of leaves were only developing. The infestation was well scattered over the plants and consisted of winged lice and colonies of young. On watermelon, muskmelon, and cucumber the infestation was starting at this date. The large plants were infested, whereas seedlings were not. On this date okra was found heavily infested, the lice of the second generation reproducing on seedling plants; this infestation was well started. The infestation on three sizes of squash and pumpkin plants was found to be light although general.

A week later the infestation on cotton was reduced, and a large proportion of the lice present were winged. The infestation was much heavier on the replant cotton. On watermelon, muskmelon, and cucumber the lice had almost disappeared since the last date of observation, but the infestation on okra had increased. The infestation just persisted on squash and pumpkin during this period.

During June the infestation on cotton decreased so that by June 25 no lice were found on this host. During the month no lice were found on watermelon, muskmelon, and cucumber. The infestation during this month decreased on okra and most of the lice were wingless. No lice were found on cowpea during this entire season. The lice disappeared entirely on squash and pumpkin during June. At no time were lice observed on eggplant, although it was grown adjacent to the other host plants.

Summary: The habits of this plant louse were quite similar during the two seasons of observation. The infestation started on cotton at practically the same date and increased for two to three weeks; then it decreased and persisted throughout the summer. With the coming of cool weather in the fall the infestation increased for a period and decreased before the occurrence of the first frost. The infestation on the cucurbits started soon after that of cotton, and the plants died before the excessive heat of the summer. Okra was heavily infested during the early summer and a light infestation persisted throughout the summer. During the fall this infestation increased. On squash and pumpkin the lice increased slowly and persisted until the extreme heat of summer. There was no fall infestation on these hosts. The louse was found on cotton in the field from May 24 to December 8. On okra the lice were present from May 24 to October 1. The infestation on cucurbits has been of short duration,—the months of June and July.

MIGRATION TESTS.

In order that more information might be secured concerning the life history, alternate food plants, and hibernation of this plant louse, migration tests were made. These were conducted in the insectary with seedling plants in the usual type of cage. In all cases the winged lice were transferred; this form being the usual migrant. The transfer was considered successful if the winged lice produced young which matured and reproduced on the new host. In many instances young were produced by the winged lice, but for one reason or another such young failed to mature on a host. In the past, the presence of a louse on a plant was considered sufficient evidence that this plant was a host. This has led to a very lengthy list of host plants for several species of lice, and such lists are misleading. In this work many times the winged lice would remain on a plant a day or two before leaving it, without producing any young. With the above mentioned standard of a host plant many were included in a list of hosts for this insect. The color variation is mentioned in this work, but the full significance of this phenomena is not fully understood at this time. For many years this color variation has been noted, and in the first part of the account mention was made of the definite existence of the lice color forms. In this work the dark form is olive green, and the light form is lemon yellow.

Cotton.

The transfer of lice from cotton was easily successful at any time of the year, either the dark or the light form. The life history proceeded without interruption whenever this transfer was made.

During January, 1916, eight transfers of the dark form were made from watermelon in the insectary. These transfers were all repeated and slight infestation resulted on cotton, although a very large proportion of winged lice developed. In January, 1917, three trials were made of this transfer, and a light infestation resulted in one case. On May 18, 1917, a transfer was made of the light form but no young were produced.

In January, 1916, two transfers were made of the dark form, but no young were produced. In October, 1916, four transfers were made, and no young lice were produced. In June, 1917, a transfer was made of the light form, which did not succeed.

During January and March, 1916, five transfers were made of the dark form from cucumber, and no young resulted from any transfer. In October a transfer was again made of this form, and a colonization resulted. In March, 1917, four transfers were made of the dark form, but no young were produced. In April, 1917, two transfers of the light form were made, but these were not successful.

Transfers were made from okra with both forms, and colonization resulted in every case, regardless of the time of the year. On cowpea only the light form was ever produced. Transfers were made from this host in March and April, 1916, and colonization resulted. Only one transfer was made from squash. This was with the light form and, although young were produced, they never developed. In December, 1916, a transfer was made of the light form, from pumpkin, which resulted in a colonization. In March, 1917, two transfers were made of the dark form. In one case colonization resulted. Transfers were made from begonia, of both forms, during the winter, and colonization resulted in every case.

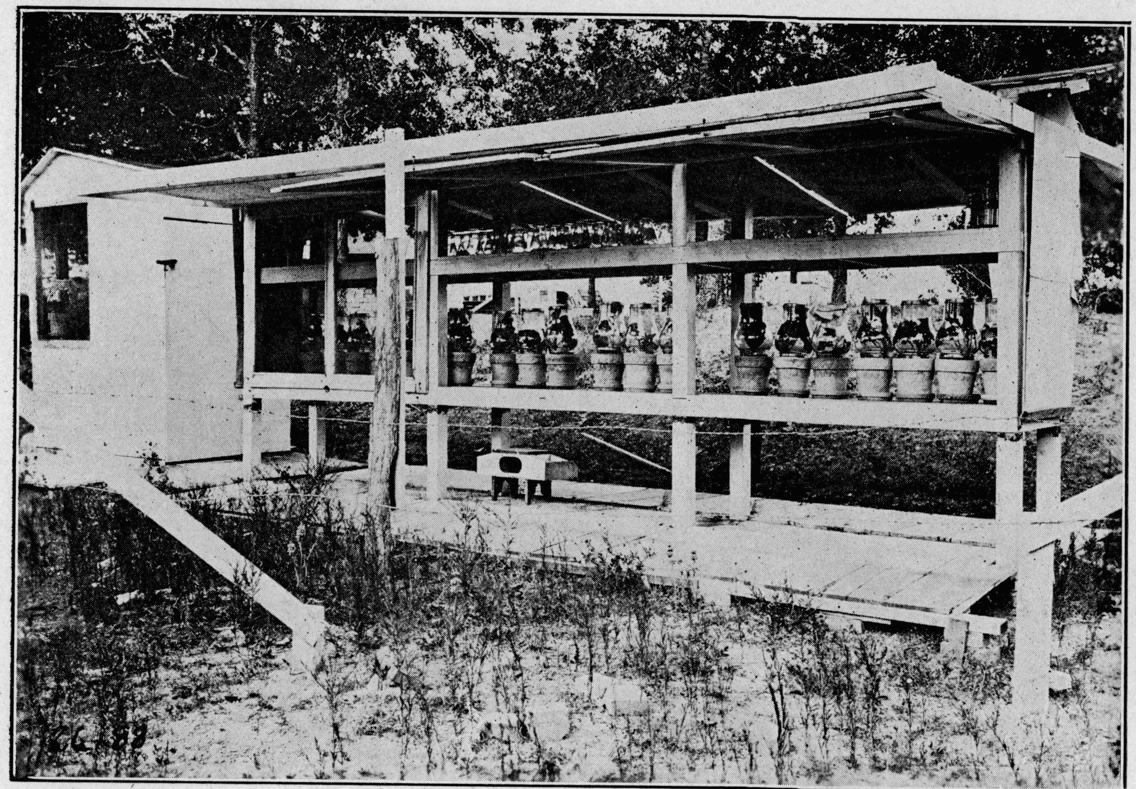

Plate IV. Cage Shelter. (Texas Bulletin 227.)

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Watermelon.

Transfers were made with both forms from watermelons, and colonization resulted in every case, even throughout the winter in the insectary. During May, 1916, four transfers of the light form were made from cotton, but no young were produced. This transfer was repeated again in March, 1917, with the same results. During February, 1916, six transfers were made of the dark form from cotton, but no young were produced. During March, 1917, seven more transfers were made of the dark form from cotton, and again no young were produced. Migration may take place at any time from muskmelon and cucumber with either form. Only the dark form was transferred from okra in October, 1916, and March, 1917. Three tests were made, but no young were produced. Only one transfer was made of the light form from cowpea, but no young were produced. During April, 1917, two transfers of light form from squash were made. Colonization resulted in both cases. Both forms were transferred from pumpkin, but the light form did not colonize.

Muskmelon.

During the fall of 1916 eight transfers were made of the light form from cotton, but colonization did not take place in a single instance. In the spring of 1917 four transfers were made of the dark form and three of the light form, but no young were produced. Colonization occurred in all the transfers from watermelon at any season. Both forms were transferred from cucumber, and colonization took place. Only the dark form was transferred from okra, but no young were produced in the four transfers made. Only the light form was transferred from cowpea, and in one case a slight infestation did occur. From squash and pumpkin only the light form was transferred, but colonization took place.

Cucumbers.

During May, 1916, five transfers were made of the light form from cotton, but there was no colonization in any case. During October seven transfers were made of the light form again, and no young were produced. The dark forms from cotton were transferred eight times during the month of March, 1917, and no infestation resulted. Only the dark form of watermelon and muskmelon was transferred, but colonization took place at all times. Transfers of either form from cucumber would colonize at all times of the year in the insectary. The dark form was transferred from okra in October, 1916, and colonization took place. On May 10, 1917, the light form of squash was transferred, and lice colonized on cucumber. From pumpkin the light form was transferred, and a severe infestation resulted on cucumber. During June, 1916, two transfers were made of the light form of cowpea, but no young were produced.

Okra.

Both the light and dark forms were transferred from cotton, and colonization resulted in any season. In October, 1916, the dark form of watermelon was transferred, and the lice colonized; but when the light form was transferred in June, 1917, no young were produced. In November two transfers of the dark form were made from muskmelon, and no lice were produced; but an infestation did result from a transfer of this form in June, 1917. At the same time the light form did not produce young when transferred. From cucumber the light form was transferred in November, 1916, but no young were produced. In December, 1916, the dark form was transferred, and young lice were produced, but they did not develop. However, the lice did colonize when the dark form was transferred in March, 1917. The one transfer of light form from cowpea in June, 1916, resulted in an infestation. From squash one transfer was made in May, 1917, of the light form which resulted in an infestation. The dark form of pumpkin was transferred in March, 1917, and young were produced.

Cowpea.

Transfers were made at all seasons of both forms from cotton which always resulted in a heavy infestation. The dark form of watermelon was transferred in October, 1916, and a slight infestation occurred, but no young were produced when the transfer was made of the light form in June, 1917. During October, 1916, four transfers were made of the dark form from muskmelon, but no young were produced. A few young lice were produced when a transfer of the dark form of cucumber was made, but no young were produced. A slight infestation resulted when the light form was transferred in June, 1917. Only the dark form of okra was transferred four times in October, 1916, and three times in March, 1917, but no young were produced. A light infestation resulted when the light form was transferred from squash in May, 1917. In December, 1916, no young were produced when the light form was transferred from pumpkin, but in May, 1917, a slight infestation resulted. In March, 1917, the dark form was transferred, and an infestation was produced.

Squash.

During September, 1916, a transfer from cotton was made with the light form, which resulted in a severe infestation. The same was true when the dark form was transferred in March, 1917. The dark form from watermelon was transferred during all seasons, and an infestation resulted each time. No young were produced when the light form was transferred from muskmelon, but when the dark form was transferred an infestation resulted. Only the dark form was transferred from cucumber during October, 1916, and March, 1917, but each produced an infestation. The dark form from okra did not establish on squash, but when the light form was used an infestation resulted. The light form from cowpea was transferred four times during November, 1916, but no young were produced. Both forms from pumpkin established whenever transferred.

Pumpkin.

Only the light form was transferred from cotton and in each case an infestation resulted. Both the dark and the light forms from watermelon established when transferred. From muskmelon both the light and the dark forms were transferred, and in all cases infestation was produced. A normal infestation was produced when the dark form was transferred from cucumber in March, 1916, and when the light form was used in June, 1917. Only the light form from cowpea established itself when transferred in November, 1916. All transfers from squash established themselves at any time.

Gourd.

The light form of cotton was transferred in September, 1916, four times; and young lice were produced, but they did not mature. In December, 1916, the dark form was transferred from cotton. Again, young lice were produced, but they did not mature. In March, 1917, the dark form was transferred from watermelon, which transfer resulted in an infestation. The dark form was transferred from cucumber in March, 1917, and established on gourd. From okra the dark form was transferred four times, and no lice were produced. An infestation resulted when the dark form was transferred from pumpkin.

No artificial migration from any source was successful on eggplant, sweet pepper, nasturtium, garden bean, or soy bean.

Summary.

From the above notes on artificial migration tests it is possible to make some deductions which will be of service in the consideration of the possible life history of this insect. It appears very doubtful whether the lice migrate to cotton from watermelon, from muskmelon, or from cucumber. Migration will take place from cowpea and okra at any time. Migration from squash and pumpkin may take place. Begonia may serve as a winter host for this species to infest the fields in the spring. There is no migration to watermelon, from cotton, from okra, or from cowpea. Migration among the cucurbits is free at all times. From squash and pumpkin migration may occur. To muskmelon there is no migration from cotton and okra, and it is doubtful from cowpea. The migration from squash and pumpkin is not of common occurrence. To cucumber there is no migration from cotton or cowpea, but some from okra, from squash, and from pumpkin. To okra the lice will migrate from all the hosts with the possible exception of cucumber. To cowpea the lice will migrate from cotton, watermelon, okra, squash, and pumpkin. Only the light form from muskmelon and cucumber will establish on cowpea. There is no migration from cowpea to squash, but from all the other hosts the lice will establish themselves. To pumpkin the lice will establish from all the hosts except okra. There is no migration to the gourd from cotton and okra, but the lice will establish from watermelon, cucumber, and pumpkin.

There is a free migration between cotton and okra at all times, but more restricted between cowpea and cotton. There is a free migration between cotton and okra and the cucurbits. There is a possible migration between cotton and squash, between cotton and pumpkin, and between these plants and the cucurbits.

HIBERNATION.

From the field observations made at College Station it is evident that this plant louse feeds on cotton very late in the winter. In December young apterous lice were found in the fields, which fact would indicate that the insect can withstand rather low temperatures. However, the infestation is decidedly reduced after killing frosts in the fall. In the southern part of the State, where cotton is growing in the fields throughout the winter, this insect will readily pass that portion of the year in the field. During the winter the periods of life history are merely lengthened.

ALTERNATE HOST PLANTS.

A review of the seasonal notes will show that there is a part of the year during which this insect is not found upon any cultivated host plant. In both years the lice were first observed in the field about May 24, which is nearly as early as the plants are of sufficient size to attack. The general infestation in the field continues until the first killing frost, October 15 to 26, at College Station. A slight infestation has been observed until December 8. This louse has not been observed to colonize on any plant other than the cultivated plants as listed.

ANNUAL LIFE HISTORY.

From what has just been said it is evident that the life history of this insect in all sections of the State is still a perplexing problem. The louse usually appears in the field as soon as cotton is developing the second or third pair of leaves. If cucurbits are available at this date, they also are attacked, although in most sections these plants are not infested until a few weeks later than cotton. The migration tests show that the louse will go from cotton to cucurbits, or from them to cotton. The infestation on cotton increases during the month of June, and then decreases during July and August. The same is true of the infestation on okra. On the cucurbits the infestation increases with greater rapidity and continues until the plants are killed. The louse is present on cucurbits growing in this locality. During September and the first half of October the infestation gradually increases, but after the first killing frost the lice leave the cotton very rapidly.

RELATION OF ANTS.

The relation of aphids to ants has been recognized for many years. As early as 1883 Jones(14) called attention to the fact that three species of ants were commonly attending cotton lice. Only one of these species was identified by him as *Myrmica malesta.* In 1910 Marsh(15) records a very close relationship between this aphid and *Formica cinereorufibarbis* Forel. Recently Horton(16) has given an account of his extended observations on the relation of the Argentine ant, *Iridomyrmex humilis* Mayr., to this plant louse.

In the present work, ants attending the lice were first observed in the insectary on March 9, 1916. At that time the host plants growing in the benches were heavily infested with lice. A careful examination showed that several colonies of ants were well established in the soil; and apparently the ants were just beginning their scouting operations at this time, for they were observed on several of the host plants, although lice were not present on all. However, the ants were most numerous where the lice were most abundant, on cotton and on okra.

On March 23 an ant in its travel over a cotton plant was observed to detect an egg of a syrphid. Immediately the ant became excited and almost instantly began tearing the egg, which came loose from the leaf before the shell was broken. With its load, the ant started down the stalk to the ground and to its nest, which was seven feet from the plant. After going about six inches from the plant the egg was laid down, apparently so the ant could rest. During the journey to the nest many ants were passed, some of which stopped to inspect the load, but none made any attempt to relieve the first ant.

By April 1 colonies of ants were quite numerous in the benches. At the base of a heavily infested squash plant there was a colony of ants. These ants seemed to confine their travel to the plants in the immediate vicinity of their nest. Four feet away was another nest, but the ants from this nest never worked close to the other. Two adult lice were observed crawling on the ground close to the base of a squash plant. Many ants passed these lice but with no more concern than to get around them and on their way to the plant. When lice were placed close to the hole of the nest, the ants seemed concerned only with getting around the lice and on with their errand.

In the field the ants were found attending the lice as soon as they were established on the plants May 24, 1916. Three species of ants were present at that time. They were determined by Dr. W. M. Wheeler as *Dorymyrmex pyramicus* Reg. sub. sp. *flavus* Mac Cook; *Solenopsis geminata* Fabr. sub. sp. *xyloni* Mac Cook; *Dorymyrmex pyramicus* Reg. sub. sp. *brunneus* Forel. When first observed the ants were working almost wholly on cotton. On this host the louse infestation was most advanced, and the ants were observed to visit the nectaries on the under sides of the leaves. No ants were found on any of the cucurbit plants that were being grown for the host plants adjacent to the cotton. On okra where the plants became heavily infested, the ants became numerous.

Throughout the fall the ants were present whenever lice were found on cotton. A large cage was maintained at this season for the study of the relation of ants to the lice. No ant nests were established within the cage, but visits were made to the cage from nests fifteen feet distant. The nests were generally in soil that had not been cultivated during the season, between the cotton plants in the rows. Throughout this period of observation no ant was seen to care for a louse in any way. Lice of all stages were seen on the ground at different times, but when not on the plant they were quickly passed up by the ants. On November 22, 1916, small colonies of lice were found by following the travel of ants. The only attention given to the lice was to obtain the honey dew. At this season the few lice present in the fields were always well attended by the ants.

The following spring many of the ant nests that had been observed in the fall were dug up carefully. This was done just before cotton was planted. In no instance was it possible to detect any plant louse in any stage being cared for in the ants' nests.

From what has been observed concerning the relation of ants to this plant, it would appear that the ants are able to collect great quantities of honey dew and that they may afford protection to the lice in so far as the eggs of predacious enemies are destroyed. The ants are not dependent upon the lice as they secure much food from the nectaries of the cotton. The lice are not dependent upon the ants as they become established previously.

NATURAL ENEMIES.

This plant louse is subject to the attacks of several enemies. Field notes show that the combined attacks of these enemies may result in almost wiping out an infestation of lice. The value of these enemies is hard to appreciate, for much of their work is often unnoticed.

PARASITES.

Lysiphlebus testaceipes Cress.

This parasite has been found in large numbers wherever this plant louse was found. In fact, the parasite is known in literature as the melon louse parasite. It does, however, feed extensively upon other common plant lice, some of which are closely associated with the cotton or melon louse. The original description of this parasite was given in Bulletin 180 of this Experiment Station.

Parasites were first observed in the field on May 25, 1916, which was the next day after the first lice were observed on cotton. The number of parasites increased steadiy, and by June 5 the lice present were heavily parasitized. The following week 95 per cent of the lice in the cages were parasitized. The adult parasites were very numerous over all the cotton in the field. Soon it was hard to find an adult louse that was not parasitized. By June 15 most of the parasites had emerged from the lice. From this date the numbers of lice were greatly reduced. On June 27 all the mature lice in the cages were parasitized. From this time on the infestation on cotton in the field was very light. During the last week in September a few parasites were again observed in the cotton field. During the cool weather of October the parasites did not increase very much and finally disappeared from the field by November 1.

PREDACIOUS ENEMIES.

These enemies are of very considerable importance in the natural factors of control of this plant louse. These enemies are not so hampered in their activity by climatic conditions as are the parasites. The predacious enemies are present every year and are present during a greater portion of the year than are parasites.

Lady Beetles.

The most important of the predacious enemies are the lady beetles or coccinelids. In both the immature and the adult stages these insects feed on plant lice. Seldom, however, do the beetles become abundant enough to exterminate the lice. Three species of coccinelids have been commonly observed in the studies on this plant louse. In order of importance they are *Megilla maculata* DeG., *Hippodamia convergeious* Guer., and *Coccinella munda* Say.

Syrphid Flies.

These enemies of the louse were commonly found in infested fields. The two species observed were *Syrphus americanus* Wied., and *Allograpta obliqua* Say. These were present in about equal numbers.

SUMMARY.

The cotton or melon louse is found widely distributed over the world. It is common throughout the United States where any of its host plants are grown. In Texas this insect is a serious pest of cotton and the melons (*cucurbits*). There has been much confusion in the identity of this species as it is supposed to have a very long list of food plants, all of which were not verified in this study.

In Texas the normal form of reproduction is asexual throughout the entire year. The alternate host plants in this State have not been determined. Fifty-one generations completed their life cycle in a period of exactly twelve months. The average reproduction period was 21.4 days and the average young produced was 84.4. The migration tests indicate that the lice do not migrate from cotton to the cucurbits or the reverse. Ants were found associated with the lice at all times, but no definite relation was established.

The plant louse is reduced by natural factors of control. One species of parasite, three species of ladybird beetles, and two species of Syrphid flies were observed to prey on this louse.

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